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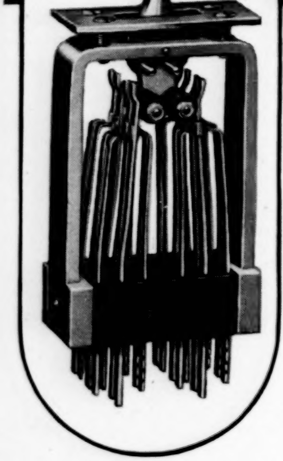

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THE

WIRELESS ENGINEER

VOL. XVI. OCTOBER, 1939 No. 193

Wireless and War

FOR months past this country had shown a tireless determination in efforts for peace. Now that the Nazi challenge has to be met that same determination is being directed to the prosecution of war.

Wireless engineers have a most important service to render to the country and already they have taken their places in the services and in industry in those tasks for which their qualifications are best suited.

In some branches of radio engineering, notably in television, a severe setback in progress is inevitable, but in other directions it is to be hoped that progress will continue unabated and that the resumption of peacetime conditions may find us still better equipped for the work of reconstruction which will lie ahead.

In this issue considerable space is devoted to a review of the Radio Exhibition, the period of which was unfortunately curtailed.

Probably the most noticeable things at Olympia were the absence of spectacular changes and the general consolidation of design. Manufacturers have confined themselves chiefly to detailed improvements. The general specification, and sometimes even the circuit, of this season's sets may differ little from last year's, but there is ample evidence of solid work when one examines the apparatus in detail.

Considerable improvement in tone-control systems has taken place, oscillator stability has been improved, larger output stages are fitted, and the mechanics of push-button tuning have been simplified and improved. In some cases the buttons now operate the wave-change switch.

Valve development has also been considerable and has resulted in a better signal-noise ratio. It is most evident to the casual observer as a reduction in the size of valves, but through the reduction of internal lead lengths which this entails the input resistance has been very appreciably increased in many cases. In its turn this has improved the pre-selection of short-wave receivers.

Television development was noteworthy for a trend towards the use of larger tubes. Very small tubes were less commonly used and large ones with a diameter of 15in. or so were more in evidence. The control had been greatly simplified and many sets had only two knobs on the panel with a few others accessible from the side or rear for occasional use. The mechanical side had not been overlooked and there were ingenious ideas for giving better accessibility for servicing.

This has also led to the production of television signal generators. These have an R.F. output modulated with sync pulses and some arbitrary test pattern and are invaluable for television receiver design and servicing.

The Screened Loop Aerial*

A Theoretical and Experimental Investigation

By R. E. Burgess, B.Sc.

(Radio Department, National Physical Laboratory)

SUMMARY.—This paper describes a theoretical and experimental investigation of the screened loop type of receiving aerial used in direction-finding and field-strength measurement.

The theory of the screened loop is analysed and the simplifying assumptions made are indicated, and are shown to lead to a good first approximation for the value of pick-up for the screened loop. The pick-up is computed for the special cases of the screen gap short circuited, capacitively loaded, and tuned. It is shown that enhanced pick-up may be obtained by the suitable capacitive loading of the gap in preference to an increase of the number of loop turns, and the practical aspect of this system is discussed.

Confirmatory experiments are described, and the paper concludes with an indication of a suggested continuation of the investigation.

1. Introduction

THE use of an overhead earthed electrostatic screen consisting of several horizontal wires to overcome antenna effect in loop direction finders was suggested by Blatterman in 1919[1] who stated that electrically a more symmetrical system was thereby obtained.

The important development due to Barfield in 1923[2] was the use for this purpose of a screen surrounding the loop, consisting of a bundle of parallel wires or a metal tube, broken at one point so as not to form a closed conducting circuit. In modern versions the screening generally consists of a tube enclosing the loop (which also gives protection against the weather and mechanical damage) or, less commonly, of a vertical cage of wires surrounding it. An examination of previous literature on the use of the screened loop in direction finding and field strength measurement failed to reveal any exact quantitative account of its receptivity. In view of certain work in progress in the Radio Department it was decided to continue the investigation of the screened loop initiated by Barfield in the above-mentioned work.

2. Theoretical Analysis of the Screened Loop

(a) General Theory.

In order to obtain a quantitative theory of the screened loop, it is necessary to make certain assumptions regarding the e.m.fs induced in the screen and loop, and the mutual actions of the currents they produce.

In the analysis developed here the following simplifying assumptions are made:

(1) That the screen and loop each have an induced e.m.f. independent of the other, and proportional to the area-turns and magnetic intensity perpendicular to the plane of the screen (or loop), the gap being sufficiently small not to affect the screen e.m.f.

(2) That the screen and loop are coupled inductively only, the coupling being expressed by the mutual inductance M.

(3) That the linear dimensions of the screen are small compared with the wavelength, and that the currents in screen and loop can be considered uniform.

This last assumption is later justified; if it is not made, the problem requires a treatment based on transmission line theory as has been recently applied to closed aerials by F. M. Colebrook.[3]

With the above assumptions, the equivalent circuit becomes as in Fig. 1. Z_1 and Z_2† are the total impedances around the screen and loop circuit, e_1 and e_2 the induced e.m.fs and i_1 and i_2 the corresponding instantaneous currents. The ratio of e.m.fs $\frac{e_2}{e_1}$ is denoted by n (assumed real) which

---

* MS. accepted by the Editor, June, 1939.

† The presence of the screen increases the self-capacitance and H.F. resistance of the loop due to its proximity. This effect is minimised by running the loop wire centrally in the screen.

tends to equality with the number of loop turns n_2 as the cross-section of the screen decreases. The Kirchhoff equations of p.d. for the two circuits are hence:

$$\text{screen} \quad e_1 = Z_1 i_1 + j\omega M i_2 \quad \cdot\cdot \quad (1a)$$

$$\text{loop} \quad e_2 = ne_1 = Z_2 i_2 + j\omega M i_1 \quad (1b)$$

where $\omega = 2\pi \times$ frequency. These equations are soluble unless $Z_2 = j\omega n M$ and $Z_1 = \frac{j\omega M}{n}$ in which case they become identical and hence indeterminate.

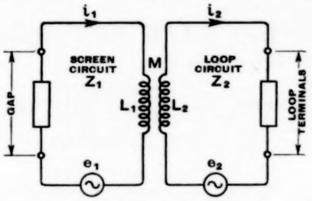

Fig. 1.—*Equivalent circuit of the screened loop.*

The solutions for the currents are

$$\text{screen} \quad i_1 = e_1 \frac{Z_2 - j\omega n M}{\omega^2 M^2 + Z_1 Z_2} = \frac{e_1 - \dfrac{j\omega M}{Z_2} e_2}{Z_1 + \dfrac{\omega^2 M^2}{Z_2}} \quad \cdot\cdot \quad \cdot\cdot \quad (2a)$$

$$\text{loop} \quad i_2 = e_1 \frac{n Z_1 - j\omega M}{\omega^2 M^2 + Z_1 Z_2} = \frac{e_2 - \dfrac{j\omega M}{Z_1} e_1}{Z_2 + \dfrac{\omega^2 M^2}{Z_1}} \quad \cdot\cdot \quad \cdot\cdot \quad (2b)$$

In the second form of each, the numerator represents the effective e.m.f. and the denominator the effective impedance. In the numerator of the loop current, e_2 corresponds to the original field and $-\frac{j\omega M}{Z_1} e_1$ to the secondary field produced by the screen.

The mutual inductance M may be defined as the linkage between the loop and the magnetic flux produced by the unit current in the screen. Since each loop turn links with the screen flux, this linkage is equal to the (number of turns) × (flux produced by unit current in the screen i.e. L_1) and hence

$$M = n_2 L_1 \text{ or } k^2 L_2 = n_2^2 L_1 \quad \cdot\cdot \quad (3)$$

where k is the coefficient of coupling between screen and loop of inductances L_1 and L_2 respectively. As already pointed out, $n(= e_2/e_1)$ will tend to equality with n_2 as the cross section of the screen decreases. In general, it will be approximately equal to n_2 and this equality will be assumed in all that follows. It is of interest to note that this equality must hold in the case of a closed perfectly conducting screen, for since there is no electric field within, zero resultant e.m.f. will act in the loop. Hence the e.m.f. e_2 in the loop due to the original field is exactly neutralised by the e.m.f. induced by the current $\frac{e_1}{j\omega L_1}$ in the screen.

$$\therefore \; e_2 - j\omega M \frac{e_1}{j\omega L_1} = 0 \text{ or } \frac{e_2}{e_1} \equiv n = \frac{M}{L_1}$$

This argument cannot, however, be used to prove the equality of n_2 and n in general, since both M and L_1 will depend to some extent on the conductivity of the screen. Substituting nL_1 for M in (2b), the loop current becomes

$$i_2 = ne_1 \frac{(Z_1 - j\omega L_1)}{Z_1 Z_2 + \omega^2 M^2} \quad \cdot\cdot \quad \cdot\cdot \quad (4)$$

It is now necessary to consider the two tuning conditions which are of practical interest: for maximum loop current, or maximum loop voltage. Let

$$Z_1 = R_1 + jX_1 \text{ and}$$
$$Z_2 = R_2 + jX_2$$

then taking C_2 as the tuning variable, the tuning condition for maximum current is given by the well-known relation

$$\frac{1}{\omega C_2} = \omega L_2 - \frac{\omega^2 M^2 X_1}{X_1^2 + R_1^2} \quad \cdot\cdot \quad (5)$$

When tuned for maximum loop current the magnitude of the latter is found from equation (5) to be

$$I_2 = ne_1 \frac{\sqrt{R_1^2 + (X_1 - \omega L_1)^2}}{\left(R_2 + \dfrac{\omega^2 M^2 R_1}{R_1^2 + X_1^2}\right)\sqrt{R_1^2 + X_1^2}}$$

$$= I_{20} \frac{\sqrt{\dfrac{R_1^2 + (X - \omega L_1)^2}{R_1^2 + X_1^2}}}{1 + \dfrac{\omega^2 M^2 R_1}{R_2(R_1^2 + X_1^2)}} \quad \cdot\cdot \quad (6)$$

where $I_{20} = \frac{ne_1}{R_2}$

is the value of the current at resonance for the unscreened loop.

The voltage tuning condition is very nearly identical with the current condition (5), except when X_1 has a value in the region of 0 or $\frac{\omega M^2}{L_2}$. Normally, and in the special cases discussed, the two conditions can be taken as identical, and the simpler current condition is therefore used.

(*b*) *Normal Operation*

When used normally, the screen gap is open-circuited and may in practice be completed with an insulator to protect the inner loop. Z_1 will then be a very large negative reactance. In this case the screen current will not be uniform along the length of the screen, and the analysis can only approximately represent the system. It indicates, however, that the terminal voltage of the loop should be very little affected by the screen, a result which is confirmed experimentally. It appears, moreover, that a non-uniform current distribution in the screen is not a necessary requirement as far as elimination of antenna effect is concerned, for, as is shown in the experimental section the efficacy of the screen in this respect is unimpaired by capacitive loading of the gap to an extent which results in an appreciable and substantially uniform screen current. It may be remarked that as e_1 and e_2 are strictly proportional to the magnetic flux linking the loop, it is reasonable to assume that the screening does not in any way affect the polarisation error of the loop or its susceptibility to local reradiation.*

(*c*) *Three Special Cases*

To compare the pick-up in the following cases, the p.d. V_2 across the loop terminals is evaluated and referred to the corresponding value V_{20} for the unscreened loop where

$$V_{20} = ne_1 \frac{\omega L_2}{R_2} = e_2 Q_2$$

Case I—Gap Short-Circuited.—Here

$$Z_1 = R_1 + j\omega L_1 \text{ so } X_1 - \omega L_1 = 0$$

In all practical cases

$$\omega L_1 \gg R_1$$

The loop tuning condition (5) becomes

$$\frac{1}{\omega C_2} = \omega L_2(1 - k^2)$$

and the loop p.d. is then found, using equation (6), to be

$$V_2 = \frac{I_2}{\omega C_2} = ne_1 \frac{\omega L_2(1 - k^2)R_1}{\left(R_2 + \frac{M^2}{L_1^2}R_1\right)\omega L_1} \text{ very nearly}$$

$$= V_{20} \frac{1 - k^2}{Q_1 + k^2 Q_2}$$

where the magnifications are denoted by

$$Q_1 = \frac{\omega L_1}{R_1} \qquad Q_2 = \frac{\omega L_2}{R_2}$$

So the short-circuiting of the gap will reduce the pick-up to 1 per cent. or less of the value for the unscreened loop, and this was confirmed experimentally by Barfield[2].

In general the magnitude of the e.m.f. acting in the loop is given by

$$e = \left| e_2 - \frac{j\omega M}{Z_1} e_1 \right| = ne_1 \left| \frac{Z_1 - j\omega L_1}{Z_1} \right|$$

$$= ne_1 \sqrt{\frac{R_1^2 + (X_1 - \omega L_1)^2}{R_1^2 + X_1^2}} \quad .. \quad (7)$$

If the screen gap is short circuited

$$X_1 = \omega L_1$$

giving

$$e = \frac{ne_1}{\sqrt{1 + \left(\frac{\omega L_1}{R_1}\right)^2}} = e_2 \frac{R_1}{|Z_1|}$$

The "screening ratio" which measures the reduction of the e.m.f. induced in the loop by closing the screen is thus

$$\frac{e}{e_2} = \frac{e}{ne_1} = \left[1 + \left(\frac{\omega L_1}{R_1}\right)^2\right]^{-\frac{1}{2}} = \frac{1}{Q_1}$$

$$\text{very nearly} \quad .. \quad .. \quad (8)$$

As $R_1 \to 0$ this ratio tends to zero implying that as the closed screen becomes perfectly conducting the field within it is reduced to zero, which is in accordance with the theory of screening of alternating electric fields.

---

* In field strength measuring apparatus which is calibrated by means of a series e.m.f., it appears to be implicitly assumed that the field acting on the loop is unaffected by the screen. An error from this source (although probably small in practice) is eliminated when the calibration is carried out on a known radiation field.

Case II—Gap Capacitively Loaded.—In this case

$$Z_1 = R_1 + jX_1$$

where X_1 is negative and $\gg R_1$

The loop tuning condition (5) becomes

$$\frac{1}{\omega C_2} = \omega L_2\left(1 - k^2 \frac{\omega L_1}{X_1}\right)$$

and the resulting tuned loop p.d. is from equation (6)

$$V_2 = \frac{I_2}{\omega C_2} = V_{20}\frac{\left(1 - \frac{\omega L_1}{X_1}\right)\left(1 - k^2\frac{\omega L_1}{X_1}\right)}{1 + \frac{R_1}{R_2}\left(\frac{\omega M}{X_1}\right)^2} \quad .. \quad (9)$$

Hence V_2 can be greater than V_{20} since X_1 is negative in the case under discussion. Thus increased pick-up may be obtained by suitable capacitive loading of the gap.

It is shown in Appendix I that the optimum loading capacitance for maximum V_2 is given by

$$C_1 \text{ opt.} = C_{10}\frac{1 - k\sqrt{\frac{1 + k^2 q}{k^2 + q}}}{1 - k^2} \quad .. \quad (10)$$

where C_{10} is the capacitance to tune the screen to ω and

$$q = \frac{Q_1}{Q_2}.$$

The resulting maximum of the tuned loop p.d. is shown to be given by

$$V_2 \max. = V_{20} \cdot \tfrac{1}{2}\left[(1 + q) + \sqrt{\left(1 + \frac{q}{k^2}\right)(1 + qk^2)}\right] \quad .. \quad (11)$$

which is $\geqslant V_{20}\left(1 + \frac{Q_1}{Q_2}\right)$

But as

$$V_{20} = e_2 Q_2$$

the effective magnification of the loop is seen to be increased from Q_2 to at least $(Q_1 + Q_2)$ by optimum loading of the gap. Theoretical curves for the variation of $\frac{V_2}{V_{20}}$ with $\frac{C_1}{C_{10}}$ are given in Fig. 2, in which $k^2 = 0.5$, and q is given the values 0.5, 1.0, 1.5. The application of gap loading to increase the loop pick-up results in an increase of effective loop inductance (Appendix I) hence, for a given wavelength, a smaller tuning capacitance is required. In an unloaded screened loop the pick-up is proportional to the number of loop turns since the Q of the loop is approximately independent of the number of turns or wavelengths.

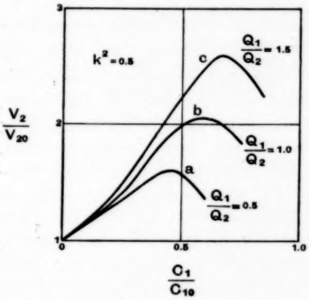

Fig. 2.—*Theoretical curves for the variation of pick-up with gap loading capacitance.*

If the pick-up is improved by either gap loading or increase of turns, the loop tuning capacitance must be decreased, the limit occurring when this capacitance is of the order of the loop self-capacitance. A general analysis given in Appendix II shows that under practical conditions gap loading will give a pick-up about 50 per cent. higher than increase of loop turns when both methods are taken to the limit set by loop self-capacitance, and this is confirmed by the test described in the experimental section.

The above considerations would apply to obtaining maximum pick-up from a given area of loop on a fixed wavelength (e.g. in aircraft or ship direction-finding).

Case III—Screen and Loop Tuned.—If the screen is tuned so that

$$X_1 = 0, \text{ that is } Z_1 = R_1,$$

the loop current will be maximum when

$$X_2 = 0, \text{ that is } Z_2 = R_2.$$

In this condition

$$\frac{V_2}{V_{20}} = \frac{\frac{\omega L_1}{R_1}}{1 + \frac{\omega^2 M^2}{R_1 R_2}} \quad \text{very nearly}$$

$$= \frac{Q_1}{1 + k^2 Q_1 Q_2}$$

$$= \frac{1}{k^2 Q_2} \quad \text{very nearly}$$

whence it is seen that the pick-up of the loop is considerably reduced. This occurs on account of the large resistance

$$\frac{\omega^2 M^2}{R_1} = \frac{\omega^2 L_1{}^2 n^2}{R_1}$$

injected by the tuned screen into the loop.

(*d*) *The Correlation of the Electric and Magnetic Viewpoints*

It is now interesting to examine the electric field conception of the injection of e.m.f. in the loop, treated in detail by Barfield[2]; namely, that when the loop is unscreened, the e.m.fs in the sides are combined vectorially to give the resultant e.m.f., while if the loop is screened the e.m.fs in the sides are reduced to very low values (to zero if the screen were perfectly conducting) but a potential difference exists across the screen gap producing an electric field which acts on the loop at the gap. From this viewpoint e.m.f. is induced into the loop almost wholly at the gap, and is proportional to the p.d. across the gap and the number of loop turns. It is seen that on dividing equation 1(b) by n:

$$e_1 - j\omega L_1 i_1 = \frac{Z_2 i_2}{n} \quad \ldots \quad \ldots \quad (12)$$

If R_1 = screen resistance, the screen impedance between the gap $= R_1 + j\omega L_1$ Therefore the gap p.d. V_g is given by

$$V_g = e_1 - (R_1 + j\omega L_1)i_1 - j\omega M i_2$$

$$= \frac{1}{n}(Z_2 - j\omega n M)i_2 - R_1 i_1$$

$$\therefore \quad i_2 = \frac{n(V_g + R_1 i_1)}{Z_2 - j\omega n M} \ldots \quad \ldots \quad (13)$$

Here the term $R_1 i_1$ appears as a small addition to V_g arising from the imperfect conductivity of the screen. This equation suggests that the screen gap behaves to each loop turn as if it were a generator of open-circuit e.m.f. V_g and internal impedance $-j\omega M$.

3. Experiments

Experiments were carried out on three different loops of which particulars are given in Table I. The screened loops were all square in shape, and both the screen and the loop were of circular cross-section. The screen of the first two loops was of aluminium tubing, whilst the third was constructed from screened flexible cable. In all the subsequent measurements the accuracy is of the order of ± 5 per cent.

(*i*) *Test of the relation* $M = nL_1$.—In the analysis it is assumed that $\frac{e_2}{e_1} = \frac{M}{L_1} = n_2$ (the number of loop turns) and although this is obviously true at low frequencies where the currents are uniform it is desirable to show that the relation is still approximately valid at high frequencies even with a high impedance gap (i.e. non-uniform screen current).

(*a*) The constants M and L_1 were measured at audio-frequency ($\omega = 5 \times 10^3$) by a Campbell bridge and radio-frequency ($\omega = 4 \times 10^7$) by means of a Q meter. The ratio M/L_1 is tabulated in columns 3 and 4 of Table II.

(*b*) In this experiment a toroid encircling one limb of the screened loop was used to produce a known magnetic flux linking with it. The toroid is useful for such measurements on account of its low external field and, by keeping the toroid circuit away from resonance, the resistance and reactance it reflects into the loop are negligible. The screen was tuned by a condenser across the gap, and the loop open-circuited. The potential differences V_1 across the gap and V_2 across the loop were measured by means of valve voltmeters and their ratio found.

If the loop impedance is taken as infinite,

$$I_2 = 0, \text{ hence } V_2 = |e_2 - j\omega M i_1| \text{ but}$$

$$\omega M i_1 = \frac{\omega M}{R_1} e_1 \gg e_2$$

$$\therefore \quad V_2 = \omega M I_1 = \omega M \frac{V_1}{\omega L_1} = \frac{M}{L_1} V_1 \text{ or}$$

$$\frac{V_2}{V_1} = \frac{M}{L_1}$$

TABLE I

Loop	Screen o.d.	Loop o.d.	Loop turns	Side of screen	Gap width
	cms.	cms.		cms.	cms.
1	3·4	0.092	1	103	2.2
2	3·4	0.092	3	103	2.2
3	0.38	0.13	1	36	1.0

This experiment has the advantage that the quantities M and L_1 are simultaneously measured under identical conditions. The last column of Table II gives the ratio of the observed voltages for the three loops, and comparison of the tabulated values shows confirmation of the relation $M = nL_1$ within the accuracy of measurement. Hence it seems justifiable to neglect any capacitive coupling between loop and screen in the approximate theory of the screened loop (assumption 2).

TABLE II

Loop	Loop turns n_2	Audio frequency M/L_1	Radio frequency M/L_1	$\frac{V_2}{V_1}$
1	1	1.06	0.96	1.05
2	3	3.11	2.85	3.10
3	1	0.99	0.99	0.98

(*c*) It might be argued that, since in normal operation the screen is open-circuited at the gap, the values of $\frac{M}{L_1}$ measured by the two previous methods are not relevant for they involved the connection of a low impedance across the gap. To check this, a known H.F. current was sent through the loop (1) and the potential difference across the gap measured with a valve voltmeter having an input capacitance of only 10 $\mu\mu$F. The values of M measured at eight frequencies by this method gave a mean of 2.64 μH as compared with 2.73 μH obtained by the previous methods.

(*ii*) *Practical Test of Gap Loading*

(*a*) *Pick-up.* With a calibrated variable condenser across the gap the variation of the tuned loop p.d. with gap capacitance was measured, using, first, an e.m.f. injected by a toroid placed round one limb of the screened loop (No. 1), and secondly, a vertically polarised radiation field. The results are plotted in Fig. 3. The curves illustrating the results obtained by the two methods agree reasonably well with each other and with the theoretical curve, which is also shown in Fig. 3. These curves all apply to the frequency of 4.6 Mc/s. and the Q values were measured by means of a "Q meter" on this frequency, correction being applied for the self-capacitance of the screen and loop. This gave $Q_1 = 67$, $Q_2 = 102$, so $q = 0.66$; also $k^2 = 0.51$ as determined from measurements of the loop and screen self and mutual inductances.

As mentioned in the discussion of Case II the upper limit of the capacitive loading of the gap is set theoretically by the loop tuning. Loop No. 1 was used since it had the smallest self-capacitance (48 $\mu\mu$F) of the three and thus permitted the largest variation of gap loading. At the peak of the loop voltage

$$\frac{C_1}{C_{10}} = 0.5 \text{ app.}$$

the theoretical value (from equation 10) being 0.50. It can be shown (Appendix I) that at this gap loading the effective loop inductance is increased by a factor of 1.5.

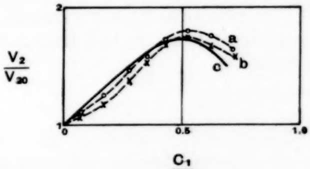

Fig. 3.—*Variation of pick-up with gap loading capacitance :*

(*a*) *measured, injection by toroid*
(*b*) *measured, injection by radiation*
(*c*) *theoretical*

It is seen from Fig. 3 that the pick-up factor has been increased by a factor of nearly 1.8 in this way. If, however, two turns had been used to double the pick-up factor, then the loop inductance would have been increased roughly fourfold and the loop self-capacitance roughly doubled so that their product would have been increased by a factor of about 8 which is certainly greater than 1.5 and would have made the loop untunable. Hence, with limitation due to loop self-capacitance, it is seen that screen loading is in this case advantageous compared with increase of loop turns.

(*b*) *Antenna Effect.*—Tests were made with a portable screened-loop direction-finder receiving a radiation field to ascertain whether gap loading and the consequent increase of current flowing in the screen impairs its screening properties, i.e. causes the appearance of antenna effect. The loop was arranged asymmetrically, one side being connected to the filaments and screening box of the receiver and the other to the grid of the H.F. amplifying valve. Used normally over a waveband of 25–50 m., the direction-finder showed no discrepancy greater than $\frac{1}{4}°$ between the reciprocal bearings, while a swing of only 1° was necessary in taking the bearings. The reciprocal effect was measured for an unscreened loop of the same dimensions in place of the screened loop, and it was found to be of the order of 10°–20°, swings of 40°–80° being required.

Loading the gap with capacitance in steps up to twice the value needed to resonate with the screen showed that no additional antenna effect was introduced thereby. It should be noted that if antenna effect is initially present (due say to stray pick-up on leads or receiver) the reciprocal error will vary as the gap is loaded since the ratio $\frac{\text{wanted pick up}}{\text{unwanted pick up}}$ is varied.

(iii) Screen and Loop Tuned

Using the direction-finder previously mentioned, capacitances were successively placed across the gap, the loop retuned, and the signal strength noted. It was observed to fall to a very low value at screen resonance. With the loading condenser less than the resonant value the loop tuning condenser had to be reduced, whilst with a greater value it had to be increased relative to its normal value.

A check was made using toroidal injection, the loop being tuned and the loop p.d. measured. The screen was then tuned and the loop potential difference remeasured. Using loop No. 1 the reduction was found to be approximately $\frac{1}{35}$ which agrees with the theoretical value of

$$\frac{1}{k^2 Q_2} = \frac{1}{0.51 \times 70} = \frac{1}{36} \text{ (at 3 Mc/s.)}$$

(iv) Tests of the Effect of the Gap Condition

(a) The result found by Barfield[2] that the gap width is without detectable effect on the loop pick-up for value of $\frac{1}{2}$in. to the smallest obtainable, was confirmed for the range 22 mm. to 1 mm.

(b) An overlapping gap was constructed having the form shown in Fig. 4, resulting in effect in the introduction of a cylindrical condenser across the gap. The only effect to be expected is a slight increase of pick-up owing to the capacitive loading of the gap.

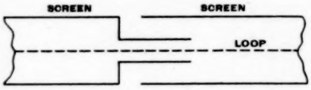

Fig. 4.—*Section through the "overlapping gap."*

Applying this type of gap to loop No. 1, it was found that an increase of 7 per cent. in the pick-up factor was obtained, which is exactly accounted for by the introduction of capacitance (25 $\mu\mu$F) across the gap.

4. Conclusion

A satisfactory simple theory of the behaviour of the screened loop in an electromagnetic field has been developed, on the basis of certain assumptions, which are stated at the beginning of the theoretical section. The further refinements of the theory which suggest themselves would require the investigation of:

1. The effect of the size and position of the screen gap upon the directional properties and pick-up of the screened loop.
2. The effect of the distributed self- and mutual-capacitance of screen and loop and the resulting non-uniformity of current.

5. Acknowledgments

The author is very indebted to his colleagues in the Radio Department of the National Physical Laboratory for their valuable guidance and interest in the investigation, and for advice on the preparation of the paper. The work was carried out as part of the programme of the Radio Research Board, and the paper is published by permission of the Department of Scientific and Industrial Research.

6. Appendices

Appendix I. (Analysis of Gap Loading).

Denoting $\frac{V_2}{V_{20}}$ by y and $\frac{\omega L_1}{-X_1}$ by x equation (9) becomes

$$y = \frac{(1 + x)(1 + k^2x)}{1 + n^2\dfrac{R_1}{R_2}x^2} \quad \frac{(1 + x)(1 + k^2x)}{1 + \dfrac{k^2}{q}x^2} \quad \ldots \ (9')$$

since

$$n^2\frac{R_1}{R_2} = k^2\frac{L_2}{L_1}\,\frac{R_1}{R_2} = k^2\frac{Q_2}{Q_1} = \frac{k^2}{q}$$

where $q = \dfrac{Q_1}{Q_2}$

If maximum current were required the factor $(1 + kx^2)$ would not occur and the optimum value of x is found to be $\sqrt{q}/k$ which corresponds to the usual resistance matching conditions. To determine the optimum value of x, $\dfrac{dy}{dx}$ is equated to zero, giving:

$$x^2 + 2x\frac{1 - q}{1 + k^2} - \frac{q}{k^2} = 0$$

The positive root of this quadratic, which is required for capacitive gap loading is

$$x_{\text{opt.}} = \frac{q - 1}{1 + k^2} + \sqrt{\left(\frac{q - 1}{1 + k^2}\right)^2 + \frac{q}{k^2}}$$

$$= \frac{(q - 1) + \dfrac{1}{k}\sqrt{(q + k^2)(1 + k^2q)}}{1 + k^2}$$

$$\doteqdot \frac{\sqrt{q}}{k} \text{ if } q \text{ is approximately unity } (Q_1 \doteqdot Q_2)$$

The value of gap capacitance C_1 corresponding to a value of x is found from

$$x = \frac{\omega L_1}{-X_1} = \frac{\omega L_1}{\dfrac{1}{\omega C_1} - \omega L_1}$$

giving

$$C_1 = \frac{x}{1 + x}\,\frac{1}{\omega^2L_1} = \frac{x}{1 + x}C_{10}$$

where $C_{10} = \dfrac{1}{\omega^2L_1}$ is the capacitance which tunes the screen to ω.

Hence the range $x = 0$ to ∞ corresponds to $C = 0$ to C_{10}. Substituting the value of $x_{\text{opt.}}$, the optimum gap capacitance is obtained

$$C_{1\text{opt.}} = C_{10}\frac{1 - k\sqrt{\dfrac{1 + k^2q}{q + k^2}}}{1 - k^2} \text{ which is} < C_{10} \ \ldots \ (10)$$

The effective inductance of the loop is then

$$L_2 - \frac{1}{\omega}\,\frac{\omega^2M^2}{X_1} = L_2(1 + k^2x) \doteqdot L_2(1 + k\sqrt{q})$$

The substitution of $x_{\text{opt.}}$ into the equation for y gives

$$y_{\text{max.}} = \frac{V_{2\text{max.}}}{V_{20}} = \tfrac{1}{2}\left[(1 + q) + \sqrt{\left(1 + \frac{q}{k^2}\right)(1 + qk^2)}\right] \quad \ldots \quad \ldots \ (11)$$

or

$$\frac{V_{2\text{max}}}{e_2} = \tfrac{1}{2}\left[(Q_2 + Q_1) + \sqrt{\left(Q_2 + \frac{Q_1}{k^2}\right)(Q_2 + k^2Q_1)}\right] \quad \ldots \quad \ldots \ (11')$$

now

$$\left(1 + \frac{q}{k^2}\right)(1 + qk^2) = 1 + q\left(\frac{1}{k^2} + k^2\right) + q^2 \geqslant 1 + 2_q + q^2$$

$$\therefore\ y_{\text{max.}} \geqslant (1 + q)$$

In practice k will lie within the limits 0.4 to 0.7 depending upon the ratio $\dfrac{\text{loop diameter}}{\text{screen diameter}}$ upon which Q_1 and Q_2 will also depend, and so by the correct choice of the ratio it is possible to secure the best value of V_2 max. The analysis only holds when X_1^2 and $(X_1 - \omega L_1)^2 \gg R_1^2$, that is away from screen resonance $(X_1 = 0)$ or short-circuit $(X_1 = \omega L_1)$.

Appendix II

If in a given screen a loop of n_0 turns be wound, then the product (loop inductance × self capacitance) may be empirically represented by an m-power law of the number of turns; that is

$$L_2C_{s2} \propto n_0^{\,m}$$

If the gap is capacitively loaded the loop inductance will be effectively multiplied by a factor $(1 + k^2x)$ (see Appendix I) and hence less turns (n) must be used to resonate with the loop self-capacitance at the same frequency for now

$$n^m(1 + k^2x) = n_0^{\,m}$$

or

$$\frac{n}{n_0} = (1 + k^2x)^{-\frac{1}{m}}$$

The pick-up of the loaded loop is increased by at least $(1 + q)$ so the ratio of pick-up is

$$> (1 + q)\frac{n}{n_0} = \frac{1 + q}{(1 + k^2x)^{1/m}} = \frac{1 + q}{(1 + k\sqrt{q})^{1/m}}$$

using the approximation $x = \dfrac{\sqrt{q}}{k}$

Hence gap loading will give the greater pick-up if

$$mq > k\sqrt{q} \text{ or } m\sqrt{q} > k.$$

In this analysis $L_2C_{s2} \propto n^m$ and the exponent of n representing practical cases probably lies between 2 and 3, since roughly $L_2 \propto n^2$ and $C_{s2} \propto n$. Typical values are $q = 1$, $k = 0.7$ for which this inequality is seen to hold, the pick-up ratio having the values

$$\frac{1 + q}{(1 + k\sqrt{q})}\,\tfrac{1}{3} = 1.67 \text{ for an } n^3 \text{ law}$$

whilst $$\frac{1 + q}{(1 + k\sqrt{q})}\,\tfrac{1}{2} = 1.53 \text{ for an } n^2 \text{ law}$$

Hence on the above premises, it may be concluded that gap loading with fewer turns is better than using the maximum number of turns without gap loading.

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The Wireless Exhibition, 1939

A Technical Survey

ALTHOUGH broadcast receivers still form by their numbers the predominant section of the Olympia Exhibition, television is rapidly catching up and there are now few firms which have not produced at least one model. Television equipment is available in four distinct forms and in each of these the vision side of the apparatus is often the same—the differences lying in the sound and subsidiary equipment.

The simplest form is the "add-on unit." This comprises a complete vision receiver and the early stages of a sound receiver. It provides a small audio-frequency output which must be fed to the pick-up terminals of any standard broadcast receiver. This is the cheapest form of television set, since a loud-speaker and output stage, some H.T. and L.T. current, and some cabinet space are saved.

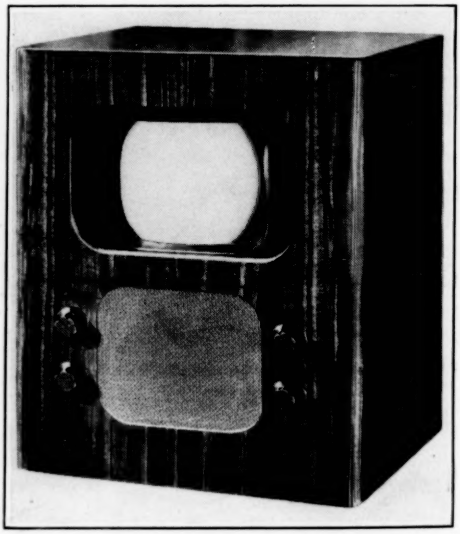
The next form is the complete vision receiver with a complete sound receiver designed for television sound reception only. Then comes similar apparatus but including in addition an all-wave broadcast set, which is usually a three-band set, covering about 16–45 metres in addition to medium- and long-wave bands. Lastly, there is equipment of this nature still further extended by the inclusion of gramophone apparatus, often an automatic record changer.

On the vision side the most notable tendency in design is towards the use of larger cathode-ray tubes. Diameters less than 7in. are not common now, and there is a distinct increase in the number of sets with tubes larger than 12in.; 14in. and 15in. tubes are not uncommon. The most popular sizes, however, are still the 9in. and 12in. tubes, which usually give pictures of 7½in. by 6in. and 10in. by 8in., respectively. A 14in. tube usually gives a picture of 11⅝in. by 9⅜in., but one firm—Cossor—use a 13½in. tube for a picture of only 10in. by 8in. This is done so that the picture is produced only on the least rounded part of the screen and a more nearly flat picture is secured.

Electromagnetic focusing and deflection are nearly always adopted, but both Cossor and Ferranti have adopted permanent magnets for focusing. Electrostatic methods are now quite rare.

Vision receivers fall into two main classes: superheterodyne and straight set, and of these the former predominates. The straight set is, however, quite popular. There is much less uniformity to be found in the methods of separating the synchronising pulses from the vision signal and in generating the saw-tooth scanning voltages or currents.

A typical superheterodyne has an R.F. stage, frequency-changer, three I.F. stages, diode detector, and one V.F. stage. The frequency-changer adopted is either a triode-hexode or a two-valve arrangement using an R.F. pentode mixer and a separate triode oscillator. Grid injection is used and the arrangement gives several times the gain of the triode-hexode, but entails the use of an extra valve.



Murphy V84T table model.

The R.F. pentodes used are nearly always special television types with high mutual conductances—of the order of 7–9 mA/V. Sometimes secondary emission valves are adopted ($g = 14$ mA/V.), but they are usually confined to the straight set, which has from two to five R.F. stages, detector, and V.F. stage.

There is a growing tendency towards the use of entirely separate sound and vision receivers, but many firms still make the early stages of the vision receiver common to both channels. The former tendency is probably brought about by the need for operating the sound equipment without the vision for the reception of those transmissions from Alexandra Palace which are not accompanied by vision. This is more difficult to arrange with combined receivers, especially when they have the same mains equipment. In H.M.V. and Marconiphone receivers the difficulty of the voltage rise when the vision receiver is switched off is overcome by changing the value of the reservoir condenser. Two condensers in parallel are used when the whole apparatus is working, and one only when the sound side is in operation.

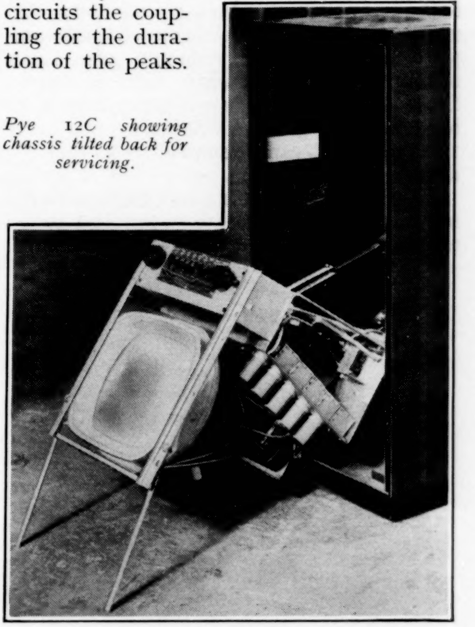
The sets produced by these firms are superheterodynes with the foregoing valve arrangement. In the case of the Marconiphone 712, which has a 14in. tube, all valves up to the second I.F. stage are common to sound and vision. The signals are then separated and each has a separate I.F. stage before the respective detectors. On sound a duo-diode is used which also acts as a noise-suppressor; this is followed by a triode A.F. stage and tetrode output valve.

The output of the V.F. stage is fed to the cathode of the C.R. tube and to a diode sync separator. A limiting valve follows and the sync pulses are taken to the hard-valve saw-tooth oscillators which are followed by tetrode amplifiers.

In some of the smaller receivers the general arrangement is similar but the diode detector and V.F. stage are replaced by an anode bend detector.

In the case of the Murphy V84, which has a 9-in. tube, the basic valve arrangement is the same but with two I.F. stages only and a two-valve frequency changer. Separation of the two signals is effected after the first I.F. stage and on sound the next I.F. stage is reflexed to act also as a first stage A.F. amplifier.

The sound detector is a diode with an ignition noise suppressor. This is a variation of a well-known circuit in which a diode is shunted across an A.F. coupling and biased so that it is non-conductive on normal signals. On interference peaks stronger than the signal, however, it becomes conductive and virtually short-circuits the coupling for the duration of the peaks.



Pye 12C showing chassis tilted back for servicing.

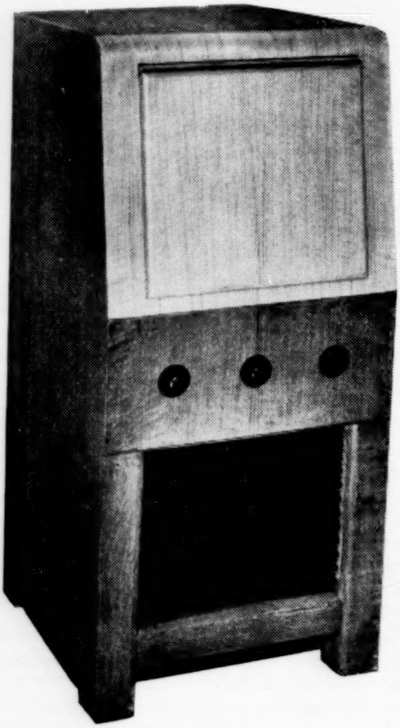
In this case the circuit has been modified so that the bias on the diode is derived through a delay circuit from the signal itself. The bias voltage thus varies with the A.F. signal but the changes are slightly delayed. A more or less constant ratio of wanted signal to bias can be maintained with the result that more effective noise suppression is secured.

On the vision side a duo-diode is used for sync separation and is fed from the cathode of the V.F. stage, the tube grid being fed from the anode. Gas-triode saw-tooth oscillators are used with pentode amplifiers.

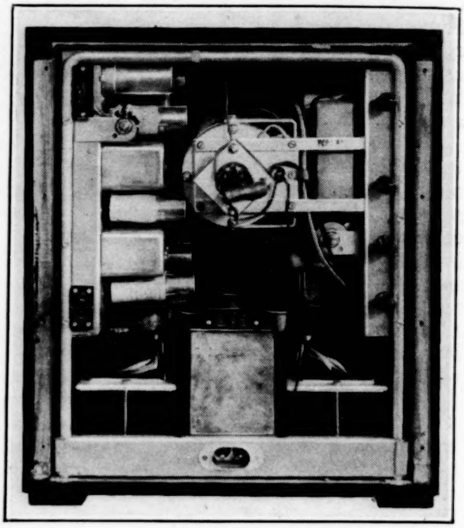
In the case of the Pye 12C a straight set with five R.F. stages is used. The detector is of the anode bend type and feeds the cathode of the C.R. tube. A single hard valve is employed for the frame time-base and a hard-valve oscillator with pentode amplifier for the line. The sound receiver is entirely separate and has two R.F. stages, detector and output valve.

This receiver is assembled on a single chassis carried by sloping supports and secured to the front of the cabinet by two screws. The "occasional controls" are behind a small flap just below the viewing window. By undoing two screws the whole chassis, complete with tube and scanning gear, slides backwards and downwards until two large hooks on its rear engage with a horizontal bar across the cabinet. This acts as a pivot and the chassis can be swung out so that the underside is accessible.

Baird are another firm to adopt the straight set and also use separate vision and sound receivers. Two R.F. stages with secondary-emission valves are employed for vision. The detector is a diode and there is one V.F. stage. The tube grid is fed from the anode of this valve with D.C. restoration by means of a metal rectifier. The triode sync separator is fed from its auxiliary cathode. Single hard-valve oscillators are provided for generating saw-tooth scanning currents and the sync pulses are fed to them through diodes. In the case of the line oscillator there is also an additional damping diode.



Baird T27 television receiver with lid covering the C.R. tube.



Ekco TA201 with tubular steel chassis frame.

Ekco are also adherents of the straight set and use three R.F. stages, diode detector, and one V.F. stage. Gas-triode saw-tooth oscillators are used with amplifiers. The sound receiver is separate with two R.F. stages. In order to avoid interference from sound the second R.F. stage in the vision receiver has a wavetrap included in its suppressor-grid circuit.

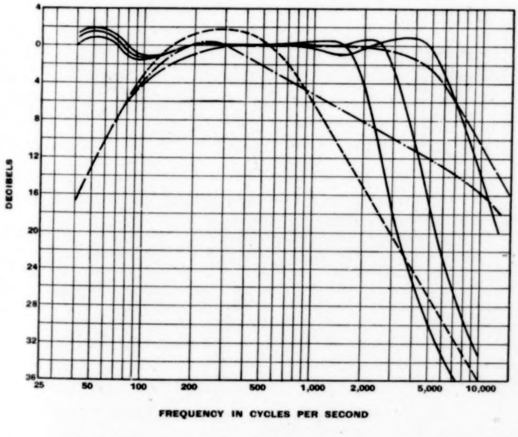
Scophony equipment differs from the rest in using mechanical scanning with the supersonic light control system. A straight set is used and the detector output is employed, after amplification, to modulate an oscillator which drives the quartz crystal of the light control cell. The smallest receiver gives a picture some 18in. by 14½in.

Broadcast Receivers

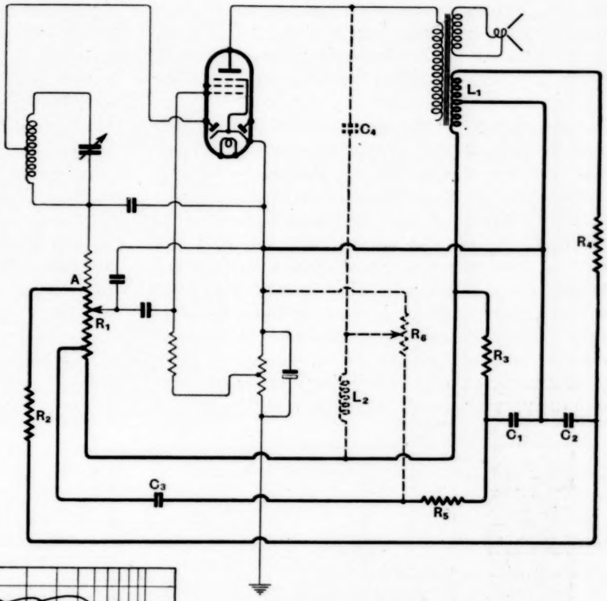
The improvements which have been effected in table model broadcast receivers during the year are mostly related to the quality of reproduction. As far as range and selectivity are concerned, there is now very little to choose between the performance of various makes of the four- or five-valve superheterodynes, and purchasers are tending to be more critical of distracting influences such as excessive background noise and too great a readiness to run into overload distortion.

As a result there is a marked increase in the average power-handling capacity of output stages. In the less expensive sets an undistorted output rating of 5 watts is common, while in sets of intermediate price, such as the H.M.V. 1200 and the Marconiphone 880, as much as 10 watts is obtained with negative feed-back from a single tetrode output valve.

(Below) Comparison of frequency response characteristics of last year's Model 650 (dotted) and a representative 1939/40 Philips receiver.



The search for better quality has also resulted in a re-examination of the claims of triodes. To maintain the standards of overall efficiency which have become established as a result of the recent popularity of pentodes and tetrodes, the triode output stage in the Bush PB63 is preceded by a triode stage in addition to the amplification provided by the triode section of the detector. In at least two of the Cossor receivers (Models 71 and 72) triodes are to be found in the output stages.

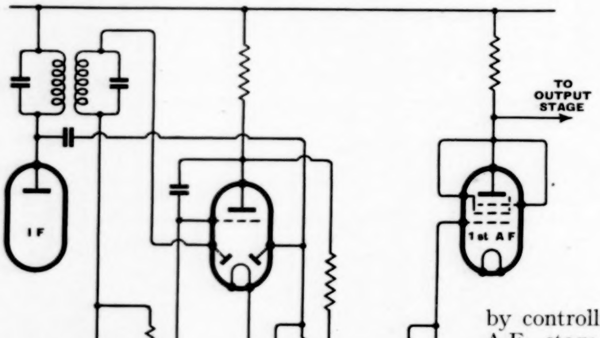


Schematic circuit diagram of the output stage in a 1939/40 Philips receiver. Back-coupling and response correction circuits are shown in heavy line and the tone control circuit in dotted line.

Efforts to clear up noises extraneous to the programme have been made in two directions (1) by the widespread use of R.F. amplifying valves with a low ratio of screen to anode current, (2) by the substitution of more effective tone control systems for the simple resistance-capacitance shunt circuit hitherto adopted.

In general, the cut-off at the upper frequency limit decided upon has been made much sharper and it is interesting to compare the response curves of current Philip sets with last year's models. The cut-off frequency of the tone tontrol circuit L_2C_4 is determined by the setting of the potentiometer R_6. A more rapid attenuation above the cut-off is brought about by injecting the by-passed high frequencies into the back coupling circuit.

The source of the back coupling e.m.f. is the centre-tapped tertiary winding L_1 on the output transformer. An out-of-phase component is fed to the bottom of the volume control R_1 and an in-phase component through R_2 to the top of R_1. Values are chosen to make the point A neutral. Thus when the volume control is at maximum on a weak station there is no feed-back and the full amplification is retained. With the control turned down on a strong signal, presumably capable of giving better quality, the advantages of negative feed-back are introduced. The filters R_3C_1 and R_4C_2 are used for high-note correction and the condenser C_3 to give a relative lift to the bass.



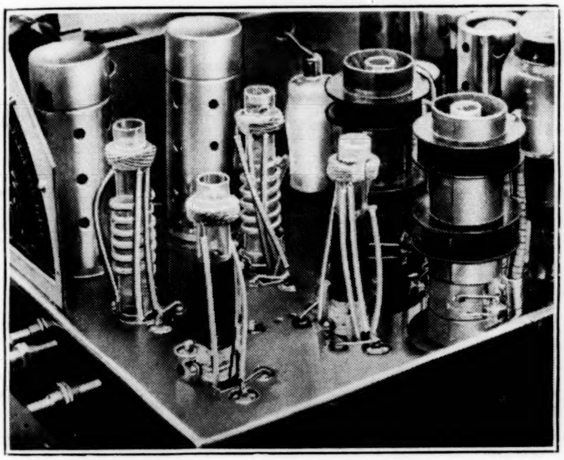
Automatic noise suppression is effected in the Cameo Model AWB by the Miller effect in the triode section of the detector stage.

Selective negative feed-back is also used in Ekco sets with filters designed to give bass and top lift. Continuous variation of tone is effected by a potentiometer which controls simultaneously the degree of feedback in both filter circuits. Many manufacturers favour a four-position tone control with clearly defined frequency response characteristics suited to conditions of listening which might be classified as " Distant," " Foreign," " Normal " and " High Fidelity." Two degrees of variable selectivity and fixed degrees of bass " boost " and top cut are used in various combinations to achieve the required result in McMichael sets.

Automatic noise suppression circuits are being introduced in receivers of all classes. In the Cameo Model AWB made by Gordon Elf, Ltd., the triode section of the detector stage is arranged to reflect a shunt capacitance across the volume control potentiometer on weak signals and thus to curtail high-note response. On strong signals the triode is biased negatively and its amplification reduced, thus limiting the Miller effect in the valve. A.V.C. is also applied to the first audio-frequency stage.

In the McMurdo Silver " 15-17 " chassis a high-gain R.F. stage is designed to give good signal-to-noise ratio on short waves and inter-station noise suppression is effected by controlling the amplification of the first A.F. stage from the A.V.C. line. Special attention has been given to coil design in the export model of this receiver and, by the use of polystyrene formers and special iron-dust cores, circuits with a " Q " of 500 at 30 Mc/s have been developed. In the audio-frequency stages a system of direct coupling has resulted in a considerable extension of the frequency response at both extremes of the range.

The control panel of the Keates-Hacker " Commander " gives some idea of the comprehensive character of this receiver. No fewer than twenty-five valves, including two R.F. stages, are brought into operation on short waves in a double superheterodyne circuit. For distant reception on medium and long waves a normal superheterodyne circuit is employed with, however, a rather special I.F. amplifier. A large number of band-pass filters, including in all twenty tuned circuits, are arranged to give four degrees of selectivity. By this means a steep-side and flat-topped characteristic is achieved even in the most selective position with a band width of 4 kc/s.

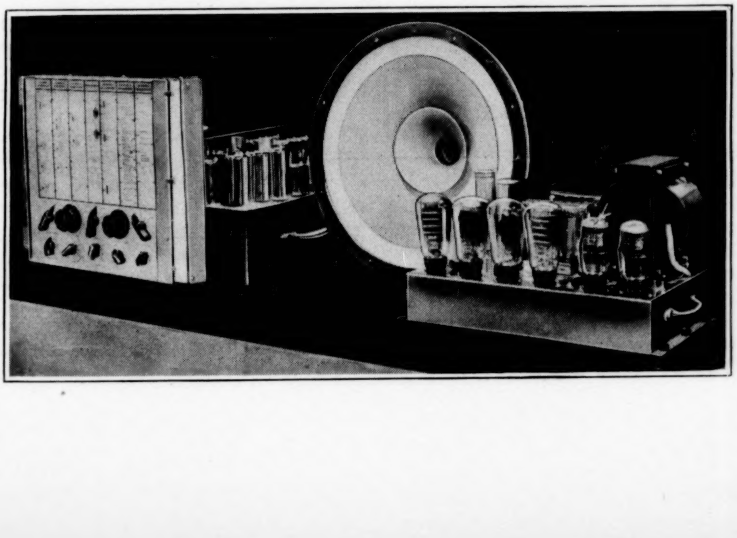


High-efficiency short-wave tuning coils on polystyrene formers in the McMurdo Silver "15-17" export model.

There are signs that greater attention is being given to efficiency of reception on short waves and many specialised receivers have been developed for this purpose. In the Pye "International" the short-wave range is divided into six sections, for each of which a tuned oscillator coil and separate image rejection circuits have been provided. Each range is expanded to the full width of the tuning scale and the settings of short-wave broadcast stations are individually calibrated. The Murphy 76 is another receiver with individual circuits for each short-wave broadcast band, and full-scale tuning expansion for each range. The emphasis is on short-wave reception in this receiver, and in a complementary set, the Model 74, first consideration has been given to high quality of reproduction on medium and long waves.

All Murphy receivers are equipped for the addition of push-button tuning, but the purchaser is not obliged to pay for this facility if he does not desire it. The push-button unit contains a number of permeability-tuned circuits and in the type designed for remote control a small electric motor drives the selector switch.

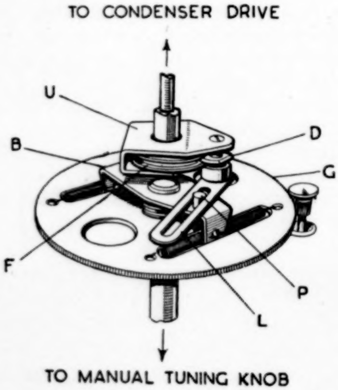
Push-button control systems, in general, are either of the mechanically operated type in which the main condenser is rotated to predetermined positions, or permeability-tuned with pre-set circuits. In most cases the interlocked switching associated with the push-buttons now automatically switches on the mains supply, no matter which button is first pressed.



The Keates-Hacker "Commander" receiver employs a "straight" circuit for high-quality reproduction, a superheterodyne for normal reception on medium and long waves and a double superheterodyne circuit for short waves.

The mechanically operated Philips automatic tuning system has been modified and now includes waverange switching whereby three of the six operating keys may be set up for either medium- or long-wave stations. The spiral vanes of the parallel-action tuning condenser have been reshaped to give a straight-line frequency characteristic.

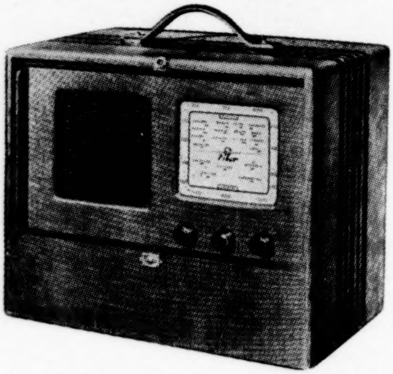
The Ekco motor-controlled tuning system has been considerably speeded up. The drive is taken through a reverse-vernier coupling which gives a direct drive in the forward direction, via the bracket *B*, the peg *P*, the bottom end of the slotted link *L* and the bracket *U*. The homing disc is allowed to overshoot slightly and when the motor reverses the peg *P* slides back along the link and imparts angular motion to the friction wheel *D* which engages with the fixed wheel *F* and so greatly increases the gear ratio between motor and condenser. The selector contacts have been modified and the gap in the homing disc is now fitted with roller contacts to minimise the effects of sparking. The mechanical accuracy of location is such that automatic frequency control circuits are no longer required.



Reverse-vernier coupling in the Ekco automatic tuning system.

The introduction of new valves with filaments requiring only 50 to 100 mA at 1.4 volts has enabled portable set designers to draw their L.T. as well as H.T. current from dry cells. Sets of this type such as the Philco P429 are usually 4-valve superheterodynes with a power output of about 200 milliwatts. The batteries supplied give a useful life of 250 hours. This is based on a filament current of 0.25 amp. and an H.T. consumption of 10 mA.

The valves used in the Cameo Model ARP are of the normal 2-volt filament type, but the set can be operated either from an accumulator or a 3-volt dry battery. A barretter maintains the correct filament current when using the latter source of supply. Another interesting extension of this type of current supply is to be found in the Pilot "Twin Miracle" portable. This set will operate from dry batteries or from either A.C. or D.C. mains. If it is disconnected from the mains or if the supply fails a relay automatically changes over to batteries with but a brief break in the programme.



Pilot "Twin Miracle" portable for operation from dry batteries or alternatively AC/DC mains.

There is little doubt that as far as broadcast receivers are concerned the progress made during the past year has shown a much greater appreciation of what might be termed the solid attributes of performance and less tendency to incorporate new features which have no advantage to offer other than novelty.

Loud Speaker Design

As far as loud speakers for receiving sets are concerned, it is gratifying to observe an increasing willingness on the part of set makers to specify units of better quality. This change of policy must come as a relief to manufacturers of loud speakers whose efforts for the past few years have been circumscribed by the low price limits set by works buying departments. The loud speaker designer has known for a long time how to produce units of much better quality than have been asked of him, but it is worth recording that there now seems to be a market for technical advances which have already been made.

In the more expensive sets where the loud speaker designer has been given more or less *carte blanche,* the twin diaphragm type is most favoured. It is usually designed to work in conjunction with an enclosed back (the so-called "infinite baffle") and the compliance of the enclosed air volume is taken into account, when working out the mechanical characteristics of the diaphragm. In the Keates-Hacker "Commander" the main diaphragm of the twin cone assembly is 18 inches in diameter, while in the McMurdo Silver two 10-inch units in separate box baffles are favoured.

The extension of frequency range in the bass which the "infinite baffle" makes possible is attended by mechanical problems, since the amplitudes developed are considerable. It is for this reason that modifications have been made in the suspension of the Goodmans infinite baffle unit, the original model of which was described in this journal a year ago. A three-point radial support is provided for the periphery of the cone, and aluminium rings are placed a short distance before and behind the "free-edge" to check the motion in atmospherics and noises resulting from circuit switching. The amplitude allowed is sufficient for adequate sound radiation down to 40 c/s.

Test Equipment

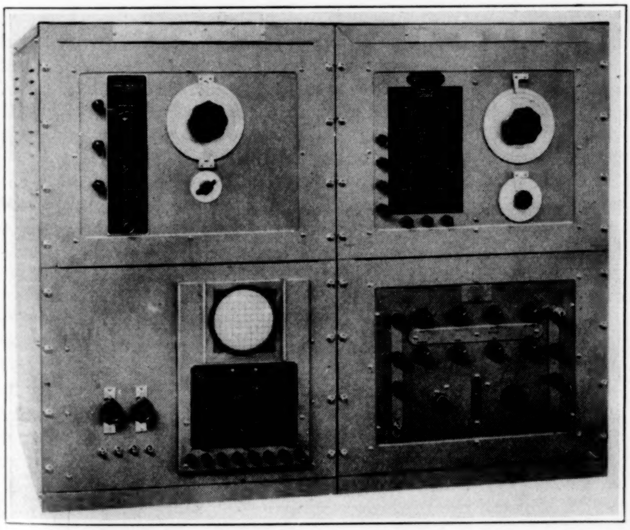
Of the new testing equipment shown at Radiolympia this year, considerable interest attaches to the apparatus developed especially for making routine tests on television receivers. One is an inexpensive service-man's-type test unit developed by the Baird Company and intended to lighten the work of dealers when installing television sets. Hitherto it has been necessary to choose a time when a transmission is available so that the performance of the set can be checked in the purchaser's house.

The Baird Sync Pulse Generator enables installation to be effected at any time, as it provides an artificial signal at radio frequency which is modulated to produce a vision pattern similar to the familiar B.B.C. test cross. This enables all preliminary adjustments to be made immediately after the installation of the set and without waiting for the television programme to commence. Thus it can be ensured that the set is in working order although the final adjustments, which being of a simple nature should quite easily be effected by the purchaser, can only be made on an actual transmission.

Where a test for time-base linearity is required, it can be effected by applying external modulation, for which provision is made, and by this means change the vision pattern to a series of vertical bars.

A continuously variable attenuator is included which gives control of the output between 200 microvolts and 2 millivolts.

On the Marconi-Ekco stand was seen television testing equipment also, but essentially of laboratory standard, although designed for production testing. De-



Cossor service equipment rack.

scribed as the Scophony Pulse Generator Type OA 134 it provides all the signals required for a comprehensive test of a television receiver, using either a cathode-ray tube or a high-definition mechanical scanner. It enables accurate and rapid tests to be effected for interlacing, linearity of time-bases, focusing and definition.

Built in standard size racks, a typical assembly would contain three main units; one for generation of the two R.F. carrier frequencies, for which crystal-controlled oscillators are used; another for vision-pattern and 50 c/s frame-pulse generators; and a third for the production of line and frame sync pulses. Both the last two mentioned include monitoring C.R. tubes.

Incorporated in the R.F.-carrier generator unit are six buffer amplifiers feeding the modulated R.F. output into 80-ohm transmission lines for distribution to testing booths or to places where the artificial signals may be required. The synchronising signals are derived from a separate master-frequency motor alternator having 405 poles and driven at 1,500 r.p.m.; this is synchronised with the A.C. mains.

This sinusoidal output is then applied to a line-pulse generator, the exact output of which is 10,125 c/s, and also to a half-line pulse generator which doubles the frequency.

For the frame-pulse generator, a 20,250 c/s input from the half-line pulse generator is divided in three stages to produce a 50 c/s output. These three outputs are then combined in a push-pull stage to produce the complete synchronising signals.

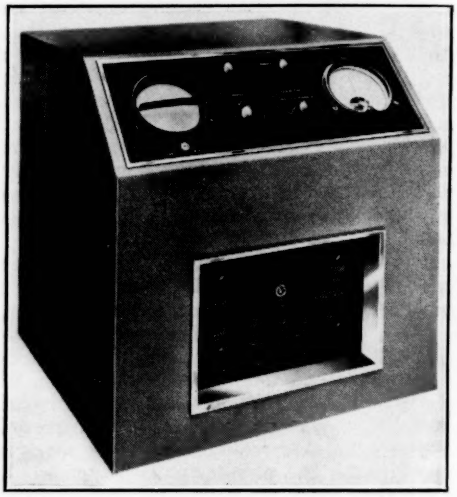
Pulses from the line and frame generators are also utilised to produce the lattice pattern signal for modulating the vision R.F. carrier.

The sound-carrier oscillator is modulated to a depth of 30 per cent. at 400 c/s.

There is also available a fourth unit containing a master television receiver for monitoring the modulated output and it could be used as a standard of comparison for receivers under test.

This year has seen a considerable extension of the application of the cathode-ray tube to receiver testing and servicing. Mullard were demonstrating its usefulness in connection with tests on television receivers, such as for visual examination of vision-signal modulation and sync pulses in a typical set.

A new piece of apparatus shown by Mullard is described as an Electronic Switch, its function being to enable two separate traces to be simultaneously observed on an oscilloscope fitted with a standard pattern C.R. tube, thereby extending its scope to the field normally covered by cathode-ray apparatus incorporating a double-beam tube. Another addition made to this firm's range of test apparatus is a small unit fitted with a 3in. hard C.R. tube and containing H.T. and grid bias supplies. Electrostatic focusing and deflection are employed, but as the neck of the tube is accessible deflection coils could be fitted quite conveniently for electromagnetic control of the beam.



E.M.I. Service cathode-ray voltmeter.

Terminals are fitted on the back of the unit for "X" and "Y" plate inputs and each is internally joined to earth *via* a 2-megohm resistance. The deflection sensitivity is 0.18 mm/V. for the "X" plates and 0.28 mm/V. for the "Y" plates.

Cossor have introduced a Radio Service Equipment Rack which accommodates the four principal units in their range of test equipment. These comprise Model 3343 Ganging Oscillator, Model 3339 Double-beam Oscillograph, Model 3389 A.C. Impedance Bridge and a new unit, Model 3391 Square Wave Generator.

The square wave is produced by applying

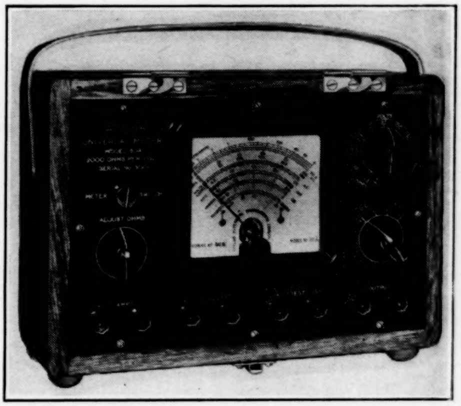
the output from a relaxation oscillator to the input of an amplifier and at a sufficient amplitude to exceed in both the positive and negative directions the acceptable grid swing of the valve. This produces in the anode circuit a wave having flat peaks and troughs with comparatively steep sides. The output is then passed to a further amplifier where the transition time from peak to trough is still further reduced, the final output having the desired square-wave characteristics.

The basic unit of this equipment is a rack containing the Ganging Oscillator, C.R. Oscillograph and a switch panel, the two other units being housed in a bolt-on extension to this rack.

An example of another application of the C.R. tube is the Cathode Ray Voltmeter developed by E.M.I. Service. Essentially a laboratory instrument, its basic principle of operation may be likened to a D.C. potentiometer in which the potentiometer setting is read on a directly-calibrated voltmeter coupled by a wide-band amplifier to a C.R. oscilloscope. The oscilloscope is used as the means for determining the portion of the wave, or input under investigation, on which measurements are required.

The frequency range of the built-in time-base is 20 to 30,000 c/s and the input capacitance is 56 $\mu\mu$F. on D.C. and 61 $\mu\mu$F. on A.C. With balanced input, for which push-pull valves are employed, these capacitances become 52.5 $\mu\mu$F. and 53 $\mu\mu$F. respectively. Six voltage ranges are available, the lowest being 0-5 volts and the highest 0-500 volts.

A comprehensive range of general servicing apparatus in which some minor improvements have been effected was shown by E.M.I. Service, and apparatus of this kind was also to be found on the stand of Taylor Electrical Instruments. In the last mentioned firm's range is included valve test sets in a variety of types, also C.R. oscilloscopes.

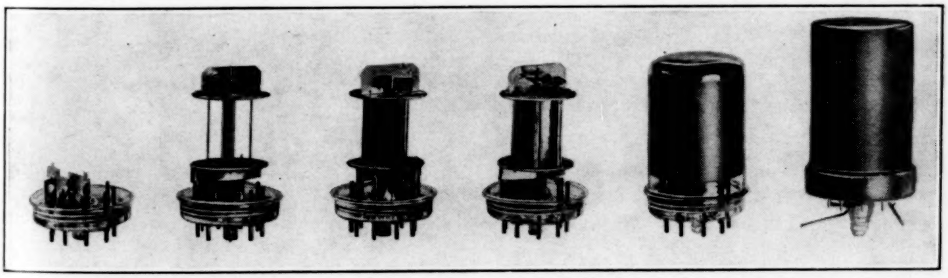


Taylor Model 80A Universal meter.

The series 80 Taylor-Meter is a particularly comprehensive test set for it provides no fewer than 70 distinct ranges, there being 14 D.C. voltage ranges covering 0.1 to 2,000 volts full scale deflection, 2.5 to 2,000 volts A.C., 10 direct and 6 alternating current ranges. In addition, capacitance, inductance and resistance measurements can be effected while there are scales also for output power and decibels in relation to 1 volt output.

Valves

One of the most interesting developments in valves is the improvement in the input resistance at ultra-high frequencies. This



The various stages in the construction of the Mullard EF50 all-glass valve are shown here.

is a trend of which we have not seen the last and it is being accomplished largely by mechanical changes in valve construction. Electron transit-time effects do not account for the whole of the input conductance and quite a large part of it in the older valves is due to the internal leads to the electrodes. By adopting methods of construction which enable their lengths to be reduced the input conductance is made very appreciably lower.

In some cases a more or less conventional arrangement is adhered to and various modifications made, including the use of a special base, to get the electrodes nearer the base pins. In other cases, the construction is radically different and the electrodes are supported on pins passing through a glass ring which actually forms part of the glass envelope, while the supporting pins emerging from the glass are also the base pins.

The Mullard and Tungsram E-series, which were introduced last year, belong to the former category, with the Mullard All-Glass valves in the latter. Only two of these are so far listed—the EE50 and the EF50. They are both intended for television purposes and the EE50 is a secondary-emission valve with a mutual conductance of 14 mA/V. Mazda have the SP41 and SP42 pentodes with mutual conductances of 8-9 mA/V. and Marconi and Osram have just introduced a new tetrode of exceedingly small dimensions with a mutual conductance of 7.5 mA/V. and an input resistance at 40 Mc/s of 4,000 ohms.

These two firms have also introduced a range of 6.3-volt indirectly-heated valves in which most types consume only 0.16 A. The consumption of certain battery valves has also been reduced and Mazda has a range rated at 1.4 volt 0.05 A. for most types. These are intended for dry-battery operation and have the Mazda octal base. Similar types, but which are counterparts of American valves, are made by Tungsram.

In addition to their normal range, Cossor have a number of special valves for television purposes. These include split-anode valves for sync separation and a triode-pentode designed for time-base work.

An electron multiplier was shown by Bosch Electronics. This is a six-stage type requiring some 300 volts per stage, or nearly 2,000 volts total. It has a mutual conductance of 40 mA/V. and an input resistance of 20,000 ohms at 45 Mc/s. It is of the grid-controlled type and suitable for use as an R.F. or V.F. amplifier.

Cathode-ray tubes for television purposes are nearly always designed for electromagnetic deflection and focusing. Tubes now made have screens ranging from 5in. to some 15in. in diameter, and in length are considerably shorter than the specimens of a few years ago. The screens now give a good black and white picture.

These tubes are usually single-anode types, often known as triodes, but there are some of hexode construction. Marconiphone and Mullard list both types, whereas the standard tubes of Mazda, Cossor, and Baird are triodes.

KTW73
Osram

Osram KTW73 "Uniwatt" R.F. tetrode.

The Industry

PARTICULARS of the latest designs of condensers and resistances for use in broadcasting and television receivers have been collected in a new "Broadcast" catalogue issued by the Dubilier Condenser Co. (1925) Ltd., Victoria Road, North Acton, London, W.3.

Varley Dry Accumulators Ltd., By-Pass Road, Barking, Essex, have prepared a leaflet describing their type V-20 cell. A spongy lead lining inside the extruded lead case forms the negative electrode. The positive element is in the form of a central lead cage and the intervening space is filled with lead peroxide moistened with the required quantity of sulphuric acid electrolyte.

The head office of Marconi-Ekco Instruments, Ltd., has been removed to Knoll Cottage, Gills Hill, Radlett, Herts. Instruments requiring factory service should, however, be sent direct to Marconi-Ekco Instruments, Ltd., Southend-on-Sea, as there will be no facilities for dealing with them at the emergency office.

Abstracts and References

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For the information of new readers it is pointed out that the length of an abstract is generally no indication of the importance of the work concerned. An important paper in English, in a journal likely to be readily accessible, may be dealt with by a square-bracketed addition to the title, while a paper of similar importance in German or Russian may be given a long abstract. In addition to these factors of difficulty of language and accessibility, the nature of the work has, of course, a great influence on the useful length of its abstract.

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PROPAGATION OF WAVES

3872. ELECTROMAGNETIC HORN DESIGN.—Chu & Barrow. (*See* 3944.)

3873. NATURAL ELECTROMAGNETIC OSCILLATIONS OF A CAVITY [in Perfectly Conducting Body: Cavity bounded by Surface of Revolution: Theoretical Method of determining Field Components, etc.].—M. Jouguet. (*Comptes Rendus*, 24th July 1939, Vol. 209, No. 4, pp. 203–204.) For other work on cavities *see* Jouguet, 3419 of September, and Borgnis, 3874, below.

3874. NATURAL ELECTROMAGNETIC OSCILLATIONS OF DIELECTRIC SPACES [bounded by Metallic Conductors: Calculations for Rectangular Solid, Cylinder closed by Planes, and Sphere: Attenuation due to Surface Currents in Boundary Surfaces].—F. Borgnis. (*Ann. der Physik*, Series 5, No. 4, Vol. 35, 1939, pp. 359–384.) For previous work *see* 3039 of 1938.

3875. DIFFRACTION THEORY OF ELECTROMAGNETIC WAVES [Direct Integration of Field Equations by Vector Analogue of Green's Theorem: Calculation of Diffraction of Waves from Rectangular Slit in Screen of Infinite Conductivity: Comparison with Exact Solution]. J. A. Stratton & L. J. Chu. (*Phys. Review*, 1st July 1939, Series 2, Vol. 56, No. 1, pp. 99–107.) For the exact solution *see* Morse & Rubenstein, 905 of March.

3876. FIVE-METRE SIGNALS AND THE WEATHER [Direct Relationship traced between Long-Range Conditions and Temperature of Upper Atmosphere relative to That on Ground].—D. W. Heightman. (*Wireless World*, 3rd & 17th Aug. 1939, Vol. 45, pp. 103–104 & 160.)

3877. SOME REMARKS ON THE QUESTION OF THE LIMITING [Critical-Frequency] WAVES [Discussion of Causes of Unreliability in Their Determination: Ionic-Cloud Scattering: Hypothesis for the Sudden Improvement in Ultra-Short-Wave Conditions].—B. Beckmann, W. Menzel, & F. Vilbig. (*T.F.T.*, June 1939, Vol. 28, No. 6, pp. 223–225.)

Appleton, Naismith, & Ingram (886 of March) have pointed out some causes of unreliability in the determination of ionisation density by critical-frequency measurements. The present writers mention that the phenomenon of lateral scattering from ionic clouds in the E region onto the F layer, described in their recent paper (2650 of July), may also lead to erroneous results. They add: "It is possible that suddenly appearing favourable transmission conditions on ultra-short waves, such as often occur for wavelengths between 5 and 10 m, may also be explained as the result of scattered rays. At any rate it is not certain that in such cases the cause is an increase of the density of the carriers. It is much more probable that the angle of incidence on the reflecting layer is so flattened by diffraction and/or refraction on the journey to the layer than an almost grazing incidence occurs.

"Refraction in the lower atmosphere can hardly play a leading part, since it would require temperature and moisture gradients not so far observed. If, however, there are present in the E region ionic clouds of suitably small dimensions, giving rise to scattering, then strongly inclined rays will fall on the F layer. The carrier density there will, in certain conditions, then suffice to cause reflection of these [ultra-] short waves. The increase of the angle of incidence by the scattering process is shown in Fig. 4.

"In Fig. 5 the critical-frequency wavelength is plotted as a function of the angle of incidence, the carrier density in the F layer being taken as

$N = 10^6/\text{cm}^3$. For vertical incidence ($\delta = 0$) the critical wavelength is 32 m. For as flat as possible a transmission from the earth's surface the angle of incidence on a layer at 300 km height is about 73°. The critical wavelength for this angle is about 9.3 m. As a result of scattering, angles of about 80° may be produced, for which the critical wavelength would be much smaller, namely around 5.5 m. The scattered energy depends only on the difference in the carrier densities in the cloud and its surroundings ; there is no variarion with frequency. Since it is probably a case of not one scattering cloud only but a large number, a considerable amount of energy will reach the receiving station, particularly as the attenuation decreases with increasing frequency." Confirmation is found in the often-observed coincidence between the appearance of the abnormal E layer and good ultra-short-wave conditions.

3878. CHARACTERISTIC VARIATION OF REGION F_2 IONISATION THROUGHOUT THE YEAR [illustrated by Curves of Critical Frequency for Similar Latitude in Both Hemispheres for Period of Constant Solar Activity : Correspondence between Ionising Radiation and Solar Activity : Asymmetry between Northern and Southern Hemisphere].—E. V. Appleton. (*Nature*, 22nd July 1939, Vol. 144, pp. 151–152.) *See* also 3437 of September.

3879. ELECTRICAL WAVES IN A STRATIFIED MEDIUM: ON THE QUESTION OF PARTIAL REFLECTION AND THE CALCULATION OF THE APPARENT HEIGHT OF IONOSPHERIC LAYERS.—K. Rawer. (*Ann. der Physik*, Series 5, No. 5, Vol. 35, 1939, pp. 385–416.) The mathematical theory of the work referred to in 3035 of August.

3880. ON A CASE OF THE PROPAGATION OF RADIO WAVES IN THE IONOSPHERE [Third Component of Splitting : Berkner & Wells's Opposition is based on Error : Tomsk Ionosphere Station's Observations, and the Fluctuating Difference between the Two Extraordinary-Ray Critical Frequencies : Explanation].—V. N. Kessenikh. (*Comptes Rendus* (*Doklady*) *de l'Acad. des Sci. de l'URSS*, No. 7, Vol. 22, 1939, pp. 416–419 : in English.)

3881. AMERICAN TESTS WITH SHORT-WAVE SIGNALS "BEAMED" ON MARS, FOR REFLECTED SIGNALS EXPLAINING LONG-DELAY ECHOES [Unpropitious Conditions, Negative Results]. —"Log-Roller." (*World-Radio*, 11th Aug. 1939, Vol. 29, p. 8.)

3882. SELECTIVE FADING IN BROADCAST RECEPTION.—Feldtkeller & Mayer. (*See* 3933.)

3883. WAVE FORM, ENERGY, AND REFLECTION BY THE IONOSPHERES OF ATMOSPHERICS.—Laby & others. (*See* 3898.)

3884. THE REFLECTION OF VERY LONG WIRELESS WAVES FROM THE IONOSPHERE [Diurnal Changes in Reflection Height agree with Reflection from Region of Chapman Type : Upper Limit to Frequency of Electronic Collisions : Long-Wave Evidence against Inclusion of Lorentz Term in Magneto-Ionic Equations].—M. V. Wilkes. (*Proc. Roy. Soc.*, Series A, 7th July 1939, Vol. 171, No. 947, p. S 69 : abstract only.) Theoretical interpretation of experimental data of Best, Budden, Ratcliffe, & Wilkes (*see* 3441 of September and back reference).

3885. THE POLARISATION OF THE RADIO WAVES REFLECTED FROM IONISED REGIONS FORMED DURING TERRESTRIAL MAGNETIC DISTURBANCES AND AURORAS.—L. Harang & W. Stoffregen. (*Hochf:tech. u. Elek:akus.*, June 1939, Vol. 53, No. 6, pp. 181–187.)

The ionised regions in question were chiefly those formed at heights of between 100 & 150 km, *i.e.* at the E-region level (Appleton, Naismith, & Builder, 1933 Abstracts, p. 613). The waves were incident vertically on the ionosphere ; their angle of inclination to the earth's magnetic field was such that the propagation could be considered as longitudinal, so that the theory (§ III) was greatly simplified. The apparatus used was a pulse emitter with corresponding receiver (§ II) enabling polarisation photographs to be taken on 8 different frequencies between 3 & 11 Mc/s ; the frame-aerial system chosen was that of Ratcliffe & White (1933 Abstracts, p. 559, bottom of l-h column) designed for polarisation investigations. Continuous registration of the echoes without regard to polarisation was also carried out over a wider frequency range. Specimen records are given (§ IV) ; it was confirmed that, for normal E-region echoes, only the normally polarised component is present, the abnormal one being absorbed. The opposite sense of rotation of circularly-polarised F-region echoes was also verified. For the ionised regions formed during magnetic storms and aurorae at E-region levels, the echoes consisted of two circularly-polarised components ; the abnormal one was less strongly absorbed than in the case of the normal E region. This was interpreted to mean that the lower boundary of the new regions is sharper than that of the normal E region. "Scattered" reflections from electron clouds gave practically no intensity changes in the echoes received on the frame aerials.

3886. THE EARTH'S ELECTRIC FIELD AND THE AURORAE [Theory : All Facts about Aurorae follow from Variation of Earth's Electric Gradient with Latitude and Occurrence of Ionisation when Electric and Magnetic Fields are Parallel : Rays coming from Sun need not be postulated].—M. C. Holmes. (*Journ. Franklin Inst.*, July 1939, Vol. 228, No. 1, pp. 63–68.) For previous work *see* 2473 of 1937 and 2176 of 1938.

3887. TWO LARGE SUNSPOTS [Groups appearing on July 3rd & 4th].—(*Nature*, 15th July 1939, Vol. 144, p. 109.)

3888. SPECTRUM OF THE LIGHT OF THE NIGHT SKY IN THE ULTRA-VIOLET REGION.—Dobronravine & Khvostikov. (*Comptes Rendus (Doklady) de l'Acad. des Sci. de l'URSS*, No. 3, Vol. 23, 1939, pp. 233–237: in French.)

3889. NITRIC OXIDE IN THE EARTH'S UPPER ATMOSPHERE [Afterglow from Weak Electrical Discharges gives Nitric Oxide Bands associated with Features of Night-Sky Spectrum: Night-Sky Radiation may originate as Low as 25 km and may be produced by Absorption of Cosmic Rays].—J. Kaplan. (*Nature*, 22nd July 1939, Vol. 144, p. 152.)

3890. REFINEMENTS IN ATMOSPHERIC TRANSMISSION MEASUREMENT FOR SOLAR CONSTANT DETERMINATION [Aircraft Photocell Precision Instrument for Two Wavelengths].—B. O'Brien. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1142: abstract only.)

3891. SOME CONTRIBUTIONS OF RADIO TO OTHER SCIENCES [Electrical Properties and Composition of Atmosphere: Meteorology: Terrestrial Magnetism: Solar Physics: Astronomy].—J. H. Dellinger. (*Journ. Franklin Inst.*, July 1939, Vol. 228, No. 1, pp. 11–42.)

3892. TESTS ON THE SUBJECT OF RADIOCOMMUNICATION WITH SUBMERGED SUBMARINES.—Houtsmuller. (*See* 4227.)

3893. NEW CONTRIBUTIONS TO THE PROBLEM OF ENERGY TRANSMISSION BY ELEMENTARY COLLISION PROCESSES.—Schüler & Haber. (*See* 4239.)

3894. THE PROPAGATION OF A [Surface] PULSE IN THE ATMOSPHERE.—Pekeris. (*See* 3906.)

3895. THE HUYGHENS-KIRCHHOFF PRINCIPLE FOR ANY NUMBER OF DIMENSIONS [General Theory].—P. O. Müller. (*Physik. Zeitschr.*, 15th June 1939, Vol. 40, No. 12, pp. 428–435.)

3896. THE PHASE ANOMALY OF OPTICAL WAVES, IN PARTICULAR OF SPHERICAL WAVES [Difference in Phase Difference between Two Points when Waves travelling between Them are Plane and of Any Other Form, in particular Spherical: Calculations: Effect of Stopping out Part of a Convergent Spherical Wave: etc.]—H. W. Breuninger. (*Ann. der Physik*, Series 5, No. 3, Vol. 35, 1939, pp. 228–250.)

3897. INVESTIGATIONS ON THE FARADAY EFFECT IN TRANSPARENT MEDIA.—Gabler. (*See* 4032.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

3898. WAVE FORM, ENERGY, AND REFLECTION BY THE IONOSPHERES OF ATMOSPHERICS [Determination of Height of Reflecting Layer and Distance of Flash: Same Velocity of Sky and Ground Waves: Linear Relation between Distance and Field Strength of Atmospheric Source: etc.].—T. H. Laby, J. J. McNeill, F. G. Nicholls, & A. F. B. Nickson. (*Proc. Roy. Soc.*, Series A, 7th July 1939, Vol. 171, No. 947, p. S 72: abstract only.)

3899. ATMOSPHERICS IN THE SOUTHERN REGIONS [Observations on Voyage show No Maritime Sources: Sources in South Africa & Madagascar.]—R. Bureau & M. Douguet. (*Comptes Rendus*, 10th July 1939, Vol. 209, No. 2, pp. 117–119.)

3900. NATURE OF ORIGIN OF THE PATH OF A LIGHTNING FLASH AND THE FURTHER PHENOMENA THEREIN.—B. Walter. (*Ann. der Physik*, Series 5, No. 7, Vol. 34, 1939, pp. 644–664.)

The writer disagrees with certain points made by Schonland and his collaborators in their recent work on the path of lightning flashes (*e.g.* 3133 of 1938) and here gives his own views, developed from work published in 1903. The discussion of the nature of origin of the flash (§ 2) refers chiefly to the magnitudes of the velocities in the various parts of the discharge and the relative positions in time of these components; it suggests that the action of the "pilot streamer" is more restricted than that proposed by Schonland, and discusses his idea of "effective velocity." Discussion of the phenomena in the path of a flash after this has been prepared by the preliminary discharges (§ 3) refers chiefly to the decrease in the illumination intensity from the lower to the higher parts of the flash and to the manner in which charge flows from the cloud into the flash. The data for many flashes are analysed in detail.

3901. MEASURING THE CURRENT IN LIGHTNING BOLTS [the "Fulchronograph" on the Tower of the University of Pittsburgh: Wheel spinning continuously at 3400 r.p.m.].—Wagner & McCann. (*Science*, 21st July 1939, Vol. 90, Supp. pp. 10 and 12.)

3902. VARIATION IN BREAKDOWN VOLTAGE OF MOLECULAR GASES DUE TO IRRADIATION.—W. Fucks & G. Schumacher. (*Zeitschr. f. Physik*, No. 9/10, Vol. 112, 1939, pp. 605–613.)

3903. THE EARTH'S ELECTRIC FIELD AND THE AURORAE.—Holmes. (*See* 3886.)

3904. SPATIAL DISTRIBUTION OF CLOUDS OF [Electric] CARRIERS PRODUCED BY PHOTO-ABSORPTION AND SCATTERING ABSORPTION IN IONISATION OF AIR BY X-RAYS: II [Theory].—H. Küstner. (*Ann. der Physik*, Series 5, No. 3, Vol. 35, 1939, pp. 193–227.)

3905. PRODUCTION OF ATOMIC RAYS AND OF COSMIC RAYS IN SUPERNOVAE.—F. Zwicky. (*Proc. Nat. Acad. Sci.*, July 1939, Vol. 25, No. 7, pp. 338–344.)

3906. The Propagation of a [Surface] Pulse in the Atmosphere [with Given Temperature Distribution : Theory : Waves of First and Second Oscillation Modes : Analysis of Records of Krakatoa Eruption].—C. L. Pekeris. (*Proc. Roy. Soc.*, Series A, 7th July 1939, Vol. 171, No. 947, pp. 434–449.) For previous theory, on "atmospheric oscillations," *see* 6 and 1679, both of 1937.

PROPERTIES OF CIRCUITS

3907. The Representation and Computation of Fluctuation Voltages [" Voltage Representation " and " Current Representation " Methods, and Their Relative Usefulness in Different Circumstances].—F. C. Williams. (*Journ. I.E.E.*, Aug. 1939, Vol. 85, No. 512, pp. 280–286.)

3908. The Noise of Thermal Agitation [in Carrier-Current Telephony : Measurements and Conclusions—Distribution Independent of Frequency, Tolerable Voltage about 1 Millivolt at End of Line, etc.].—E. Hölzler & W. Arens. (*Ann. des Postes, T. et T.*, July 1939, Vol. 28, No. 7, pp. 519–531.) French translation of a 1937 German paper.

3909. A " Resolving Bridge " for Transmission Lines, with Various Applications.—Hartig & Brunetti. (In paper dealt with in 4068, below.)

Thus a relay could be so connected that it would be actuated only by the return wave, and controlled entirely by the impedance at the line termination (sensitive remote-control device) : or a signal at *X* (Fig. 2) may be delayed from arriving at *S* by any desired amount of time by adjusting the length of the transmission line.

3910. The Evaluation of Open- and Closed-Circuit Measurements on Homogeneous Cables.—Sommer. (*See* 4070.)

3911. On the Calculation of Non-Sinusoidal Periodic Régimes [Simple Operational Method for Systems representable by Linear Differential Equations with Constant Coefficients], *and* On the " Synthetic Method " for the Study of Non-Sinusoidal Periodic Régimes.—G. Quilico : R. Sartori. (*L'Elettrotecnica*, 25th March 1939, Vol. 26, No. 6, pp. 257–263 : 10th Aug. 1939, No. 15, pp. 538–539.)

Sartori points out the usefulness of Quilico's method (which he calls the " synthetic " method) in dealing with saw-tooth oscillators as used in television, and quotes Carnahan's employment of a similar method (230 of 1936).

3912. The Application ot the Tensor Concept to the Complete Analysis of Lumped, Active, Linear Networks [using the Mellin Inversion Theorem : Application to Analysis of Shunt " Peaking " Type of Video Amplifier and of Percival/Wheeler (Low-Pass-Filters) Video Amplifier : Comparison of the Two Types as regards Noise].—D. W. Epstein & H. L. Donley. (*RCA Review*, July 1939, Vol. 4, No. 1, pp. 73–82.)

3913. Investigations on the Reduction of the " Klirr " Factor of Amplifiers, principally for Carrier-Frequency Systems.—W. Mader. (*E.N.T.*, May 1939, Vol. 16, No. 5, pp. 135–149.)

Author's summary :—" This paper shows theoretically and practically that it is possible to construct amplifiers in which the second and third harmonics are effectively zero. This is achieved by using the third harmonic which arises in retroaction, as a modulation product from the second harmonic and the fundamental, to compensate the third harmonic due to curvature of the characteristic. This method is illustrated on a push-pull stage, in which the degree of retroaction can at the same time be greatly increased by introducing a phase-correct ' pseudo-positive ' retroaction [fundamental circuit Fig. 4 ; combination with negative retroaction, Fig. 5] . . . This also decreases the second harmonic considerably. The theoretical discussion shows that, for the greatest freedom from distortion, the coefficients of the quadratic and cubic terms of the working characteristic must be in a definite ratio to one another. . . . It is further found that the presence of a cubic term of definite magnitude and sign is required for the compensation of the third harmonic arising from the decrease of the second harmonic by the retroaction circuit. A sensitive circuit (Fig. 7) is used to measure the coefficients of the higher terms of the equation to the characteristic. . . . Practical investigations with commercial valves confirm the formulae derived. Sufficient compensation is only obtained with a few specially selected valves. . . . The requirements would have to be put into practice in the development of amplifier valves if the method of ' klirr '-factor reduction were to be successfully applied." Fig. 14 gives the circuit diagram of the compensated push-pull circuit.

3914. The Input Impedance of Amplifiers with Retroaction.—H. Bartels. (*E.N.T.*, June 1939, Vol. 16, No. 6, pp. 155–160.)

The input impedance, R_e, for series retroaction (in which part of the output voltage or current is led back in series into the input circuit ; fundamental circuit Fig. 1) is worked out theoretically and given by eqn. 1. The input conductance, G_e, for retroaction in parallel (circuit Fig. 2) is also worked out (eqn. 2) and found to be of the same type as R_e, each being the difference of a constant vector and a vector proportional to v, the quotient (amplification of the amplifier without retroaction)/(open-circuit amplification). The construction of the vector v (Figs. 3–5), the diagrams for R_e and the conductance for parallel retroaction, the input impedance for a combination of series and parallel retroaction, the impedance as a function of frequency, and calculation with negative resistances, are described. The diagrams given " enable the input impedance or conductance for any given load on the output circuit of the amplifier to be read off immediately. For the special case of retroaction of a valve *via* the grid/anode capacity, the known conductance diagram of the valve is obtained. In calculations with these negative resistances, it must first be separately determined whether the systems are stable or not. It is only possible to determine the stability directly from the magnitude of the negative resistance if this corresponds to a given retroaction circuit."

3915. Filters in Open Circuit at the Output Side.—W. Cauer. (*E.N.T.*, June 1939, Vol. 16, No. 6, pp. 161–163.)

References are made to formulae in a previous paper (3510 of September). The present work extends the theory to the solution of the problem of determining the proper dimensions of the circuit elements of " filters working on the input side with a constant ohmic generator resistance and on the output side in open circuit, so that the working attenuation may have a prescribed maximum in the guaranteed pass band, and for this the minimum of the working attenuation in the guaranteed stop range may be as large as possible. It is shown that the problem is solved by half a frequency-selector circuit, of the type described in the paper referred to above." An illustrative numerical example is worked out.

3916. Three-Circuit Band-Pass Filters with Symmetrically Balanced Transmission Curves.—H. Wucherer. (*T.F.T.*, June 1939, Vol. 28, No. 6, pp. 231–238: to be concluded.)

" The theory of filters with three and more circuits has already been treated comprehensively by H. Backhaus [in 1925]. The ideal resonance curve of a three-circuit band-pass filter has three equally high humps and is completely symmetrical about the mid-point of the band. Backhaus has shown that with 'tuned' filters these equal humps can be obtained if the outer circuits are coupled to the middle circuit in the same fashion and equally strongly, *e.g.* by two equal coupling inductances or two equal coupling capacities: the outer circuits must have equal dampings, but the middle circuit must be completely undamped. In such three-circuit band-pass filters we have the Backhaus 'standard form.' This standard form cannot be developed practically because of the ever-present losses in the middle circuit; the central hump is always higher than the two outer ones. Backhaus also showed [in 1924] how equal humps could be obtained even when the middle circuit had finite losses.

" We shall show that equal humps can also be arrived at if the tuning of the circuits to the same frequency is abandoned and a change made from 'tuned' to 'detuned' filters. According to the theory of two-circuit band filters there then exists the danger of producing asymmetrical resonance curves. We counter this danger by detuning the outer circuits symmetrically with respect to the middle circuit. Band filters with similar (*e.g.* inductive) couplings display a further fundamental asymmetry of resonance curve, particularly evident as a greater steepness of the upper flanks: with two capacitive couplings it is the lower flanks which are steeper. We counter this asymmetry by coupling the first circuit to the middle circuit capacitively, and the last circuit to the middle circuit inductively."

The present instalment deals with the theory of the three-circuit band filter, beginning by defining what the writer means first by a " detuned " filter, as compared with an " un-detuned " one (such as is obtained by tuning three separate circuits to the same frequency and then coupling them together by mutual inductances) and then by a " symmetrically detuned " filter, which is what he is aiming at. The final instalment will deal with the design calculations of such a filter; with its construction and adjustment; with the results of measurements; and finally with its applications.

3917. Low-Pass Filters for Time-Delay Circuits [More Rapid Operation with Less Distortion in Automatic Modulation Control Circuits].—J. H. Owens. (*QST*, Aug. 1939, Vol. 23, No. 8, pp. 19–20.) " The fastest possible time delay [with a resistance-capacity filter] is far too slow for syllabic build-up."

3918. Notes on the Equivalence of Electrical Networks.—G. Calabrese. (*Gen. Elec. Review*, July 1939, Vol. 42, No. 7, pp. 323–325.)

3919. Two Simple Equivalent-Circuit Diagrams for the Calculation of Networks with Differential Transformers, with Special Attention to the Forked Connection.—G. Kamphausen. (*T.F.T.*, June 1939, Vol. 28, No. 6, pp. 220–223.)

3920. The Four Equivalent-Circuit Diagrams of the Transformer.—H. Pitsch. (*Funktech. Monatshefte*, June 1939, No. 6, pp. 171–174.) Further development of the work referred to in 2703 of 1938.

3921. Graphical Delta/Star Transformation [for the Simple Calculation of Resistance Networks such as an Unbalanced Bridge Circuit].—H. Williges. (*T.F.T.*, May 1939, Vol. 28, No. 5, pp. 200–202.)

3922. Determination of the Circular Currents of Two Current Rectifiers in Cross Connection, with the Aid of the Voltage Diagram.—W. Bulla. (*Arch. f. Elektrot.*, 14th June 1939, Vol. 33, No. 6, pp. 402–410.)

TRANSMISSION

3923. A Short-Wave Generator [with Circuit Potential Arrangements of Barkhausen Oscillator: Split-Anode Valve with Two Single Thin Grid Wires Equidistant from and Parallel to Filament: Lecher-Wire System attached to Anodes: No Magnetic Field but Mode of Action resembles That of Split-Anode Magnetron: Good Range of Wavelengths (*e.g.* 1 m–3 m, with Optimum at about 160 cm)].—E. W. B. Gill. (*Phil. Mag.*, Aug. 1939, Series 7, Vol. 28, No. 187, pp. 203–208.)

" The oscillations are extremely weak." The suggested mechanism of the process explains the fact that for a fixed grid voltage an increase in emission reduces the wavelength.

3924. Ultra-High-Frequency Resonances in the Positive-Grid Triode.—R. A. Chipman. (*Proc. Phys. Soc.*, 1st July 1939, Vol. 51, Part 4, No. 286, pp. 566–574.)

The grid of a triode with cylindrical electrodes was maintained at a positive potential, and the anode at a small negative mean potential, with respect to the filament. Anode current flowed when an oscillating potential was superposed on the mean anode potential; its magnitude was determined as a function of the grid potential. "There were maxima of anode current for certain values of grid potential . . . these could be interpreted in terms of a fundamental or harmonic resonance between the period of the applied oscillating potential and the time of transit of the electrons between different pairs of electrodes in the triode."

3925. THE INFLUENCE OF SPACE CHARGE IN A PLANE RETARDING FIELD [Theory].—W. Kleinsteuber. (*Hochf:tech. u. Elek:akus.*, June 1939, Vol. 53, No. 6, pp. 199–214.)

The introduction gives a summary of papers on the effect of transit time of the electrons in valves used for production or amplification of oscillations. The work of Bakker & de Vries (1390 & 3374 of 1935) neglected the effect of space-charge on the electron motion; the present paper aims at including this and at finding a relation "between the alternating voltage on the electrodes (grid and retarding electrode), the alternating current flowing from the electrodes (generator current), and the alternating magnitudes (current, velocity) impressed on the incoming electrons, so that it may be possible to reach a conclusion as to the equivalent impedance of the retarding-field generator."

The electrode system discussed is shown in Fig. 1. Starting from Maxwell's equations, the motion in a stationary retarding field is first investigated; Fig. 2 shows the electron paths for this case, Fig. 3 those for a small alternating field. The rising and falling parts of the paths are different analytic functions of the transit time. Fig. 4 (§ II) gives curves for the transit time and field-strength at the retarding electrode as functions of the voltages on the grid and the retarding electrode. For given electrode distance and current density, there is a maximum value of the transit time. For zero voltage on the retarding electrode and grid voltages below the limiting value which corresponds to maximum transit time, the electrons do not arrive at the retarding electrode. § III deals with the case of a small alternating field acting on a direct current entering the inter-electrode space with constant velocity. The differential equations governing the electron motion are set up, so that the alternating voltage between the electrodes can, in principle, be calculated. In § IV these equations are simplified (giving eqns. 20) and eqn. 22 is found for the alternating voltage. The initial conditions are generalised in § V, which discusses the case when the electrons enter with a small alternating velocity (functional differential equations, eqns. 25). In § VI the alternating voltage is assumed to be small and sinusoidal, and the current and velocity to enter the inter-electrode space with constant values. Series and numerical methods of solution can now be applied; eqn. 42 gives the connection between current and voltage. In § VII, eqn. 42 is first specialised to the limiting case of vanishing space charge, giving eqn. 44, which agrees with the result obtained by Bakker & de Vries (*loc. cit.*). The iteration method is then used to determine the effect of space charge; curves for a numerical example are given in Figs. 5, 6, showing the positions of the oscillation regions. It is found that the number of these is finite, and that for small current densities the results for zero space charge give good approximations to them. Finite amplitudes of the voltage and field strength are not here investigated, so that only the conditions of onset of oscillation can be discussed.

3926. SOME ELECTRONIC PHENOMENA RELATING TO ULTRA-HIGH-FREQUENCY OSCILLATIONS.—K. Okabe. (*Rep. of Rad. Res. in Japan*, [dated] Dec. 1938, Vol. 8, No. 3, pp. 97–99: in English.)

1.—Abnormal oscillations with a cold-cathode discharge tube (in a strong magnetic field): either of wavelength less than a few millimetres, or a combination of various wavelengths, or else of wavelengths fluctuating widely. Jonescu's results (3514 of 1938: *see* also 1410 of April) are mentioned.

2.—Abnormal electronic phenomena in a magnetic-field tube.

3.—"Peculiar controlling" of electron current: the circuit is utilisable as amplifier or amplidetector for ultra-short waves.

3927. ON FREQUENCY STABILISATION OF THE ULTRA-SHORT-WAVE TRANSMITTER [Previous Systems: Essential Conditions for a Frequency Stabiliser, leading to Design of Closed Coaxial Cylinder with Short Inner Cylinders sliding on Inner (2-Part) Conductor, and Fixed Discs: Advantages over Kolster Circuit (Less Radiation, Wider Frequency Range)].—H. Uchida. (*Rep. of Rad. Res. in Japan*, [dated] Dec. 1938, Vol. 8, No. 3, pp. 117–123: in English.)

3928. FOUR-BAND TRANSMITTER [7 . . . 56 Mc/s].—S. K. Lewer. (*Wireless World*, 13th & 20th July and 3rd Aug. 1939, Vol. 45, pp. 26–29, 66–68, and 105–106.)

3929. PORTABLE EMERGENCY TRANSMITTERS: FIVE VARIATIONS IN COMPACT EQUIPMENT DESIGN.—(*QST*, Aug. 1939, Vol. 23, No. 8, pp. 22–29 and 86.)

3930. EXPERIMENTAL INVESTIGATION OF THE DISPLACEMENT OF A FREQUENCY BAND OF THEORETICALLY ARBITRARY WIDTH THROUGH A DESIRED PHASE ANGLE [by displacing the Phase of a Single Auxiliary Carrier Frequency on which is impressed a Single-Sideband Modulation by the Given Frequency Band: Oscillographic Confirmation].—F. Vilbig. (*T.F.T.*, Dec. 1938, Vol. 27, No. 12, pp. 560–561.)

3931. POLYPHASE BROADCASTING.—Byrne. (*See* 4229.)

RECEPTION

3932. A NOISE-FREE RADIO RECEIVER FOR THE RECEPTION OF FREQUENCY-MODULATED ULTRA-SHORT WAVES: DISCRIMINATES AGAINST NOISES AND INTERFERENCE: CHARACTERISED ALSO BY HIGH AUDIO FIDELITY.—G. W. Fyler & J. A. Worcester, Jr. (*Gen. Elec. Review*, July 1939, Vol. 42, No. 7, pp. 307–310.) A summary was referred to in 2742 of July. For another receiver *see* Day, 3542 of September.

3933. Selective Fading in Broadcast Reception [Experimental Investigation of Short-Range Interference Phenomena between Sky and Ground Waves, often giving (even with Linear Detection) Strong Selective Non-Linear Distortion].—R. Feldtkeller & A. Mayer. (*T.F.T.*, Dec. 1938, Vol. 27, No. 12, pp. 561–566.)

Among the conclusions reached is that the zone of distortionless reception could be increased by diminishing the percentage of modulation (objections to this being the limited sensitivity of the "Small" receiver, but chiefly the resulting increased chance of interference); or by an increased selective amplification, at the receiver, of the carrier frequency compared with the sidebands; or, finally, by changing over to single-sideband transmission, as has often been suggested already for other reasons.

3934. A Stammering Signal [on Short Waves: Unexplained Effect from Station showing "Double Hump" in Tuning].—"Log-Roller." (*World-Radio*, 28th July 1939, Vol. 29, p. 3.)

3935. The Question of Industrial Parasites in Broadcast Reception [Survey of Work (chiefly German & Italian) on Measurements on Power Networks, etc: Recent Italian Results: Difficulty in obtaining General Agreement as to Legislative Steps].—E, Paolini. (*Alta Frequenza*, June 1939, Vol. 8. No. 6, pp. 377–389.)

3936. General View-Points of Interference Suppression [including the Difficult Case of Switches, and Its Solution by the "Larsen Connection"].—K. Kegel. (*AEG-Mitteilungen*, Aug. 1939, No. 8, pp. 380–383.)

3937. A Special Case of Low-Frequency Broadcast Interference from a Mercury-Rectifier Supply System [Usual Smoothing Equipment quite Unable to prevent Widespread Interference due to Unusual Harmonics in the D.C. Mains, produced by Back Action of 6-Phase Rectifier onto the 3-Phase Supply, combined with Resonance Effects in the Latter].—R. Moebes. (*T.F.T.*, June 1939, Vol. 28, No. 6, pp. 238–241.)

A smoothing choke of about 1.3 mH combined with a balancing battery was finally found to be efficacious.

3938. Low-Cost Cure for Radio Interference [Use of Copper-Oxide Glaze to prevent Minute Arcing at Points of Contact of Wires and High-Voltage Pin-Type Insulators].—(*Scient. American*, June 1939, Vol. 160, No. 6, p. 350: photograph & caption only.) *See* also Aggers, *Electrician*, 4th Aug. 1939, Vol. 123, p. 118.

3939. Regeneration in the Superheterodyne [Practical Experience in the Resulting Improvement with Long-Distance ("Communication-Receiver") Types].—H. C. C. Erskine-Maconochie. (*Wireless World*, 27th July 1939, Vol. 45, pp. 77–80.)

3940. Distortionless Detection [Distortion in Diode Detection, due to A.C. Value of Load Resistance being Lower than D.C. Value, removed by Negative Feedback].—J. E. Varrell. (*Wireless World*, 3rd Aug. 1939, Vol. 45, pp. 94–96.)

3941. The High Fidelity Reproduction of Broadcast Programmes [and the Properties of the Ear which must be considered in the Design of a Receiver].—(*AEG-Mitteilungen*, Aug. 1939, No. 8, pp. 374–376.)

3942. On Push-Button Tuning for Broadcast Receivers [General Considerations, leading to Rejection of Condenser-Drive Principle], *and* The Electrical Push-Button System of the 1939/40 AEG Receivers.—W. Patzschke: W. Hering. (*AEG-Mitteilungen*, Aug. 1939, No. 8, pp. 363–366: pp. 366–370.)

3943. The AEG Broadcast Receivers for the Season 1939/40.—E. Billeter. (*AEG-Mitteilungen*, Aug. 1939, No. 8, pp. 357–363.)

AERIALS AND AERIAL SYSTEMS

3944. Electromagnetic Horn Design [with Quantitative Curves for Sectoral and (indirectly) for Pyramidal Horns: Differing Properties of $H_{0,1}$ and $H_{1,0}$ Waves as regards Quality of Beam: etc.].—L. J. Chu & W. L. Barrow. (*Elec. Engineering*, July 1939, Vol. 58, No. 7, Transactions pp. 333–338.)

3945. Antennas [Short "Guest Editorial" Survey: Will the Useful Limit of Power Gain (around 100 for Short-Wave Beam Arrays) apply also to Ultra-Short Waves? etc.].—H. H. Beverage. (*RCA Review*, July 1939, Vol. 4, No. 1, pp. 108–113.)

3946. The Two-Band Three-Element Rotary: a Close-Spaced Array for the 20 m and 10 m Bands.—E. E. Schroeder. (*QST*, Aug. 1939, Vol. 23, No. 8, pp. 16–18.)

3947. An Aerial for Wide Frequency Bands.—S. Zisler. (*E.N.T.*, May 1939, Vol. 16, No. 5, pp. 121–126.)

This aerial is a dipole with associated *L, C, R* circuit (Fig. 1), for which a numerical example is given showing a possible attenuation curve with a band width of 18.5% of the carrier frequency, and measurements (Fig. 17) giving band widths of 27%. The equivalent circuit is shown in Fig. 2, and in another form in Fig. 4. To this the band-filter theory of Feldtkeller & Tamm (2992 of 1936) is applied to find the general relations between the circuit elements and the filter properties of the aerial. A quadripole of identical properties is shown in Fig. 6, its general form in Fig. 7. Formulae (eqns. 15) are derived from which the values of the circuit elements for given values of the transmission factor can be deduced. This also determines the input impedance of the aerial. Curves showing the various magnitudes on which the band-filter effect depends are given in Figs. 8–13. Questions of matching are discussed in § 5.

3948. Radiation Coupling of Straight Parallel Wires (in Particular for Progressive Waves).—W. Jachnow. (*E.N.T.*, June 1939, Vol. 16, No. 6, pp. 164–175.)

This paper extends the theory of aerials with standing waves, developed in work such as that of Pistolkors (1929 Abstracts, p. 329) and subsequent writers, to the case of progressive waves along the aerials. The method of integration along the radiator itself, and determination of the energy put into the separate radiators, using the Hertzian vector, is chiefly employed (*see* also Bechmann, 1931 Abstracts, pp. 96–97). The Poynting vector method is also used to check the results. Part I gives the calculation of the radiation coefficients of a system of two parallel straight linear aerials along which undamped progressive waves are travelling. The results in the most general case are expressed in formulae 26, 30, & 31. The special cases of two aerials of equal length, height, and phase, of one straight linear aerial, of one power line with progressive waves, and of the radiation coupling of two coaxial radiators with progressive waves, are separately considered and the results given in the form of curves. In Part II the work is generalised to the case of one aerial driven with progressive and standing waves; the radiation coupling between these two types of wave on the same aerial is calculated (Fig. 12). Fig. 13 shows the radiation resistance of a straight wire of length three times the wavelength, as a function of the percentages of stationary and progressive waves in the total current.

3949. Simplifying the Adjustment of Antenna Arrays [Use of the Type 2A Phase Monitor].—J. F. Morrison. (*Bell Lab. Record*, Aug. 1939, Vol. 17, No. 12, pp. 390–396.) *See* also 3566 of September.

VALVES AND THERMIONICS

3950. Cathode-ray Bunching [Mathematical Treatment of Bunching in Klystron].—D. L. Webster. (*Journ. of Applied Phys.*, July 1939, Vol. 10, No. 7, pp. 501–508.) For the klystron *see* 2773 of July and back references [*also* 3575 & 3595 of September].

3951. Magnetic-Field Valves with Asymmetrically Slit Anodes [Higher-Order Oscillations ("B" Type) obtained as Efficiently as with Symmetrical Tube, with Reduced Difficulties in Construction, Water-Cooling, etc.].—S. Hamada & T. Simidu. (*Rep. of Rad. Res. in Japan*, [dated] Dec. 1938, Vol. 8, No. 3, pp. 111–115: in German.)

3952. A Mechanical Model [in Form of Gyroscope] for Electron Motion in a Uniform Magnetic Field [giving Electron Paths for Deflection Plates in Uniform Field, Diode in Axial Magnetic Field, Split-Anode Magnetron, etc.].—A. Rose. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1144: abstract only.)

3953. The Influence of Space Charge in the Plane Retarding Field.—Kleinsteuber. (*See* 3925.)

3954. Effect of Electron Transit Time on Efficiency of a Power Amplifier [Experimental Comparison of Plate Efficiencies of Triodes as Power Amplifiers and as Oscillators: Explanation of the Great Superiority of Former: Discussion of Results, with Application to Design of Power-Amplifier Valves].—A. V. Haeff. (*RCA Review*, July 1939, Vol. 4, No. 1, pp. 114–121.)

3955. A Push-Pull Ultra-High-Frequency Beam Tetrode [Type RCA-832: giving 10–13 W Useful Output around 250 Mc/s, with Efficiency of 45%].—A. K. Wing. (*RCA Review*, July 1939, Vol. 4, No. 1, pp. 62–72.) A summary was referred to in 3605 of 1938.

3956. Present-Day Technique of Vacuum Apparatus for Very High Voltages [including Demountable Transmitting Triodes, continually connected to Pump: Advantages for Ultra-Short-Wave Generator (Grid-Currents of Thousands of Amperes admissible, No Fear of Release of Gas, Small Superheated Cathode of Short Life, etc.)].—M. Matricon. (*Bull. de la Soc. franç. des Elec.*, June 1939, Vol. 9, No. 102, pp. 511–529.)

3957. New Valves in the 1939/40 AEG Broadcast Receivers [Current-Economising "U" Series for Universal Models: the New ECL 11 and EM 11: etc.].—G. Fellbaum. (*AEG-Mitteilungen*, Aug. 1939, No. 8, pp. 371–373.)

3958. Variation of the Anode Effect with Temperature [Studied in Special Diode: Rapid Decrease of Observed Anode Effect with Anode Temperature].—P. L. Copeland. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1145: abstract only.) By "anode effect" (Nottingham, 1932) is meant the acquisition, by the plate of a valve, of surface charges which alter the contact potential relative to a hot filament.

3959. The Representation and Computation of Fluctuation Voltages.—Williams. (*See* 3907.)

3960. The Action of Positive Ions on a Space-Charge-Limited Electron Current [Calculations for Plane Problem: Importance of Potential Minimum in Front of Cathode: Ionic Space-Charge Effect gives Sufficient Explanation: Increase of Space-Charge Effect with Electron Emission].—J. Bott. (*Ann. der Physik*, Series 5, No. 4, Vol. 35, 1939, pp. 329–332.) For experiments *see* Kienzle, 1251 of 1938.

3961. The Dispenser Cathode: a New Type of Thermionic Cathode for Gaseous Discharge Tubes [Coating Material "dispensed" at Uniform Rate to Initially Uncoated Cathode Members, from "Dispenser" located within Common Heat Shield: Cathode Emission does Not Decrease with Time].—A. W. Hull. (*Phys. Review*, 1st July 1939, Series 2, Vol. 56, No. 1, pp. 86–93.)

3962. The Vapour Pressure and Rate of Evaporation of Barium Oxide.—J. P. Blewett, H. A. Liebhafsky, & E. F. Hennelly. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, pp. 1138–1139 : abstract only.)

3963. The Range and Validity of the Field Current Equation [Currents from Cold Cathodes in High Vacua : Deviation from Millikan/Lauritsen Equation].—F. R. Abbott & J. E. Henderson. (*Phys. Review*, 1st July 1939, Series 2, Vol. 56, No. 1, pp. 113–118.) For the Millikan/Lauritsen equation *see* 1928 Abstracts, p. 344.

3964. Emission of Electrons from Copper, Silver, and Aluminium on the Impact of High-Velocity Ions [Measurements].—E. Grassmann. (*Ann. der Physik*, Series 5, No. 5, Vol. 35, 1939, pp. 465–472.)

3965. Thermionic Constants of Tungsten for Various Crystallographic Directions [Measurements showing that All Attempts to relate Observed to Theoretical Values of Emission Constants have so far No Great Significance].—M. H. Nichols. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1144 : abstract only.)

3966. Electrolytic "Polishing" of Tungsten [Possible Method for Preparation of Filaments for Electron Emission Studies].—J. M. Hughes & E. A. Coomes. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1138 : abstract only.)

DIRECTIONAL WIRELESS

3967. A Cathode-Ray Goniometer-Type Direction Finder [Modification of Watson Watt Design : One-Dial Control of the Three Receivers : "Test Oscillator" dispensed with by Calibrating with Signal E.M.F. on the Vertical Aerial, after Amplification].—T. Tukada. (*Rep. of Rad. Res. in Japan*, [dated] Dec. 1938, Vol. 8, No. 3, pp. 125–133 : in English.) "The most satisfactory form of direction finder for short-wave use."

3968. The Calibration of Four-Aerial Adcock Direction Finders [Determination of Closest Range of Test Transmitter for Avoidance of "Proximity" Errors (between 0.6λ and 3.5λ in Most Practical Cases) : Mathematical Treatment, Practical Application of Results].—W. Ross. (*Journ. I.E.E.*, Aug. 1939, Vol. 85, No. 512, pp. 192–202.) For points in a Discussion *see* between pp. 207 and 214. *See* also 3969.

3969. Symposium on Radio Direction Finding : Introductory Remarks.—R. L. Smith-Rose. (*Journ. I.E.E.*, Aug. 1939, Vol. 85, No. 512, pp. 203–207 : Discussion pp. 207–214.) Introducing and summarising six papers from the Radio Department of the N.P.L. which have been dealt with briefly in past abstracts, including 3968, above. The question of "four-poster" *versus* "two-poster" systems occupies much of the Discussion and Reply.

3970. The Recent Trend of Radio Direction-Finding [Short Survey].—R. L. Smith-Rose. (*Nature*, 22nd July 1939, Vol. 144, pp. 139–140.)

3971. An Indicating Arrangement for Short-Time Measuring Apparatus, based on Exploring-Ray Scanning.—Winckel. (*See* 4262.)

3972. Steering by Television [Some Systems of applying Television to Direction Finding and Blind Landing, already Subject of Patents].—(*Wireless World*, 20th July 1939, Vol. 45, pp. 51–52.)

3973. Radio in Aviation : a General Survey, with Special Reference to the Royal Air Force [Aerials & Earths, Power Supply, etc : Vibration Effects : Noise : Effects of Temperature Changes and of Lowered Atmospheric Pressure (in reducing Insulation and Efficiency of Speech-Input) : Fire Risk, Shock, Lighting : Direction Finding : etc.].—N. F. S. Hecht. (*Journ. I.E.E.*, Aug. 1939, Vol. 85, No. 512, pp. 215–237 : Discussion pp. 237–241.)

ACOUSTICS AND AUDIO-FREQUENCIES

3974. A Cardioid Directional Microphone [Western Electric No. 639 AA : Combination of Diaphragm and Ribbon Transmitters].—R. N. Marshall. (*Bell Lab. Record*, July 1939, Vol. 17, No. 11, pp. 338–342.)

3975. Microphones at Alexandra Palace.—(*Wireless World*, 29th June 1939, Vol. 44, pp. 613–614.)

3976. Rochelle-Salt Microphones of the S.A.F.A.R.—(*Alta Frequenza*, July 1939, Vol. 8, No. 7, pp. 485–487.)

3977. Papers on Rochelle Salt.—Mason : Bantle & Scherrer. (*See* 4076 & 4077.)

3978. Exponential Loudspeaker Horns [Calculation of Curvature of Sides for Various Lengths].—(*Wireless World*, 20th July 1939, Vol. 45, pp. 48–50.)

3979. The Resonant Radial Frequencies of a Cylinder with Any Wall Thickness.—G. S. Field. (*Canadian Journ. of Res.*, July 1939, Vol. 17, No. 7, Sec. A, pp. 141–147.)

For a very thin wall the frequency equation becomes very simple, but contains an additional factor compared with the equation usually given for a thin-walled cylinder : it is suggested that the two cases correspond to slightly different types of vibration, and that the one considered here is physically more likely.

3980. The Theory of the Telephone Receiver [Electro-Magnetic Type].—A. Ferrari-Toniolo. (*Istituto Elettrotec. Naz. Galileo Ferraris*, Reprint No. 51, 23 pp.)

3981. The Locus Curves of the Resistance of [Audio-Frequency] Coils with Iron Cores, taking into Consideration the Frequency-Dependent Hysteresis Loss.—K. Braun. (*T.F.T.*, May 1939, Vol. 28, No. 5, pp. 165–170.)

Author's summary:—It is shown how, with the help of the formulae given by Richter [book, pub. 1924] for the calculation of the iron losses in power engineering, the iron losses occurring in the iron-cored coils used in communication technique may be represented and replaced by a resistance. The locus curves obtained for the resistance of such components, by the use of these formulae, are circles whose centres lie not on the real axis but more or less below this according to the magnitude of the hysteresis losses. The circles, moreover, do not touch the imaginary axis but cut it more or less. The locus curves agree satisfactorily with the measured results [on call bell, telephone receiver, and telephone transformer. An editorial comment at the end points out among other things that the circular locus curve postulates a truly sinusoidal wave-form for the induction and flux as well as for the voltage: this is not strictly the case, on account of copper losses, etc.].

3982. Electric Gramophone [for Highest Quality of Reproduction].—M. G. Scroggie. (*Wireless World*, 27th July 1939, Vol. 45, pp. 72–75.) For previous work *see* 2820 of July.

3983. The Magnetophone [New Model "K4"].—B. Müller-Ernesti. (*Funktech. Monatshefte*, May 1939, No. 5, pp. 151–154.)

3984. Recording on Steel Tape [for Office Use and for coupling to G.P.O. Telephone System to record Conversations].—(*Wireless World*, 29th June 1939, Vol. 44, pp. 611–612.)

3985. The Distortions accompanying the Reproduction of Optical Records of Sound Waves, due to the Non-Uniform Illumination of the Slit.—M. A. Koroleva. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 9, 1939, pp. 239–248.)

An analysis is given of distortions resulting from non-uniform illumination of the slit, when the latter (a) is infinitely narrow and (b) has a finite width. Formulae determining "klirr" factor are derived, and from considerations of the maximum permissible linear and non-linear distortions the suitable width of the slit is determined.

3986. Investigations on the Transition Points between Registers in Singing: II—Disturbances of Tone due to the Action of the Natural Mouthpiece [Mouth, Nose, and Throat].—W. Trendelenburg. (*Sitzungsber. der Preuss. Akad. der Wiss.*, Phys.-Math. Class, 20th Oct. 1938, No. 21, pp. 188–226.)

3987. The Automatic Synthesis of Speech.—H. Dudley. (*Proc. Nat. Acad. Sci.*, July 1939, Vol. 25, No. 7, pp. 377–383.) For previous work *see* 3599 of September.

3988. Practical Design for an Electronic Piano.—(*Electronics*, May 1939, Vol. 12, No. 5, pp. 30–33.)

3989. Dynamics of the Pianoforte String and the Hammer: Part II—Elastic Hammer.—M. Ghosh. (*Indian Journ. of Phys.*, Dec. 1938, Vol. 12, Part 6, pp. 437–453.)

3990. Old Violins ["Speak" more easily than Modern Instruments: Search for Physical Reason].—F. A. Saunders. (*Science*, 19th May 1939, Vol. 89, Supp. p. 12.)

3991. Transmission of Sound through Plates at Oblique Incidence [Strong Transmission in Region below Normal Critical Angle: Sharp Intense Transmission Maxima in Three Regions at Angles of Incidence greatly in Excess of Critical Angle: Agreement with Theory].—F. H. Sanders. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1127: abstract only.)

3992. On the Absorption of Sound Waves upon Reflection from a Solid Boundary.—B. P. Konstantinov. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 9, 1939, pp. 226–228.)

A theoretical investigation is presented of the sound absorption which takes place when plane sound waves fall perpendicularly or obliquely on a flat wall. Kirchhoff's classical work on sound propagation in a viscous and heat-conducting medium is discussed, and formulae are derived determining the coefficient of sound absorption D for the following two limiting cases: (a) when the wall is an ideal heat conductor, and (b) when it is a heat insulator. It appears that D is higher for waves falling obliquely and that at a certain angle it reaches a maximum value of 82.84%. This value is independent both of the nature of the gas in which the propagation takes place and of the heat-conducting properties of the reflecting wall.

3993. Sound Insulation of Walls and Floors [Report BMS 17].—Nat. Bureau of Standards. (*Tech. News Bull. of Nat. Bur. of Stds.*, June 1939, No. 266, p. 58.) *See* also *Journ. Franklin Inst.*, July 1939, Vol. 228, No. 1, pp. 92–93.

3994. Acoustic Properties of Mud Bricks [Measurements of Sound Absorption and Insulation: Greater Absorption for Irregular than for Smooth Surface].—F. H. Constable & M. K. Mahas. (*Nature*, 1st July 1939, Vol. 144, p. 33.)

3995. Theory and Design of the Simplest Resonance Sound-Absorbing Systems.—S. N. Rschevkin. (*Comptes Rendus* (*Doklady*) *de l'Acad. des Sci. de l'URSS*, No. 9, Vol. 22, 1939, pp. 564–569: in English.) Primarily in connection with the ceiling of the large hall of the Palace of the Soviets.

3996. The Acoustical Design of Broadcasting Studios [Preliminary Survey of Absorption by Resonance: Batten-and-Panel Construction].—J. McLaren. (*World-Radio*, 11th Aug. 1939, Vol. 29, pp. 14–15.)

3997. The Acoustical Study of Large Rooms by means of Models.—A. Gigli. (*Istituto Elettrotec. Naz. Galileo Ferraris*, Reprint No. 55, pp. 3–10.) The reprint contains also Gigli's paper dealt with in 3207 of August.

3998. Room Noise at Telephone Locations.—D. F. Seacord. (*Elec. Engineering*, June 1939, Vol. 58, No. 6, pp. 255–257.)

3999. Architectural Acoustics and Electrotechnics.—A. Gigli. (*L'Elettrotecnica*, 25th April 1939, Vol. 26, No. 8, pp. 306–311.)

4000. "Raum- und Bauakustik" [a "Text Book for Architects & Engineers": Book Review].—J. Engl. (*Akust. Zeitschr.*, May 1939, Vol. 4, No. 3, pp. 189–190.)

4001. "Electro-Acoustics" [Book Review].—E. Meyer. (*Journ. Scient. Instr.*, July 1939, Vol. 16, No. 7, p. 237.)

4002. Sound Absorption of Snow [High Absorptive Capacity shown by Shaft on Jungfraujoch].—G. Seligman. (*Nature*, 24th June 1939, Vol. 143, p. 1071.) *See* also Kaye & Evans, 1543 of April.

4003. The Objective Measurement of Noise: the Electrical Causes of Machine Noise.—Bérard. (*Bull. de la Soc. franç. des Élec.*, Aug. 1939, Vol. 9, No. 104, pp. 676–714.)

4004. Notes on the Dynamics of Instruments [with Application to Noise-Meters, etc.].—Rich. (*See* 4088.)

4005. Acoustic Radiation Pressure [Calculation of Mean Pressure and Density at Each Point of Perfect Fluid, for Infinitely Small Periodic Waves].—J. Mendousse. (*Comptes Rendus*, 19th June 1939, Vol. 208, No. 25, pp. 1977–1979.)

4006. An Investigation of the Accuracy of König's Formula for the Rayleigh Disc [Discrepancy between Theory and Experiment is due to Formation of Vortices in Medium near Disc: Empirical Equation].—A. C. Merrington & C. W. Oatley. (*Proc. Roy. Soc.*, Series A, 7th July 1939, Vol. 171, No. 947, pp. 505–524.)

4007. Method for the Harmonic Analysis of Alternating Currents [Small Alternator with Adjustable Stator (for Phase Adjustment): Thermocouple/Millivoltmeter Combination].—E. Gambetta. (*Rev. Gén. de l'Élec.*, 20th May 1939, Vol. 45, No. 20, pp. 669–675.) For corrections see *ibid.*, 1st July 1939, No. 26, p. 850.

4008. On Thermal Dependence of Elasticity in Solids [Theoretical Analysis including Influence of Temperature on Macroscopic Elasticity Coefficients entering into Propagation of Acoustic Waves].—L. Brillouin. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1139: abstract only.)

4009. The Dependence of Internal Friction in Metals on Grain Size.—R. H. Randall, F. C. Rose, & C. Zener. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1140: abstract only.) Experiments testing theory referred to in 1930 (*see* also 3723) of 1938.

4010. On the Excitation of Chladni Figures [Simple Method].—L. Sibaiya. (*Indian Journ. of Phys.*, Dec. 1938, Vol. 12, Part 6, pp. 407–408 and Plate.)

4011. An Indicating Arrangement for Short-Time Measuring Apparatus, based on Exploring-Ray Scanning [applicable to Echo Sounding].—Winckel. (*See* 4262.)

4012. Audiogoniometry in Air and under Water [Survey, and Some S.A.F.A.R. Instruments], *and* On the Cause of the Corrosion of Diaphragms vibrating in Water.—M. Federici. (*L'Elettrotecnica*, 25th April 1939, Vol. 26, No. 8, pp. 311–319: 25th July 1939, No. 14, pp. 500–502.)

4013. The "O.M. Corbino" National Institute of Electroacoustics: Researches in the Field of Supersonic Waves.—(*La Ricerca Scientifica*, June 1939, 10th Year, No. 6, pp. 580–584.)

4014. The Testing of Work Pieces [for Machining] by Supersonic Waves [including the Use of a "Wobbled" Frequency to avoid Standing Waves].—F. Kruse. (*Akust. Zeitschr.*, May 1939, Vol. 4, No. 3, pp. 153–168.)

4015. Supersonics and the Effect of Water Vapour on Molecular Vibrations in CO_2: *also* Effect of Temperature on Supersonic Velocity in CO_2: *and* Theory of Secondary Peak for Sound Absorption in CO_2.—Pielemeier & Telfair: Overbeck & Wiler: Saxton. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1127: abstracts only.)

4016. Luminescence of Water under the Action of Supersonic Waves [is due to the Presence of Dissolved Oxygen: Light comes from Decomposition of Ozone under Action of Supersonic Waves].—P. Paounoff. (*Comptes Rendus*, 3rd July 1939, Vol. 209, No. 1, pp. 33–36.)

4017. Natural Vibration and Damping of Gas Bubbles in Liquids.—E. Meyer & K. Tamm. (*Akust. Zeitschr.*, May 1939, Vol. 4, No. 3, pp. 145–152.)

4018. The Plastic-Elastic State [Theory: Necessity of including Hydrodynamical Theory for Calculations of Elasticity Moduli, Oscillations, etc., of Liquids].—K. Bennewitz & H. Rötger. (*Physik. Zeitschr.*, 15th June 1939, Vol. 40, No. 12, pp. 416–428.)

4019. The Velocity of Sound in Liquid Helium under Pressure.—J. C. Findlay & others. (*Phys. Review*, 1st July 1939, Series 2, Vol. 56, No. 1, p. 122.)

PHOTOTELEGRAPHY AND TELEVISION

4020. Post-Acceleration in Cathode-Ray Tubes.—Rogowski & Thielen. (*See* 4097.)

4021. Papers on Fluorescent Materials.—(*See* under "Subsidiary Apparatus & Materials.")

4022. The "Synthetic" Method for the Study of Non-Sinusoidal Periodic Regimes [*e.g.* in Saw-Tooth Oscillators].—Quilico: Sartori. (*See* 3911.)

4023. Capacity-Modulated Cathode-Ray Scanning Tubes.—M. Knoll & R. Theile. (*T.F.T.*, Supp. No., Nov. 1938, Vol. 27, pp. 538–540.)

"In the scanning tubes previously known the picture signal results from a change either in the number of secondary electrons set free from the screen surface, or in the resistance of the screen [*cf.* Theile, 217 of January], or finally in its charge. The present paper discusses a fourth possibility, namely the generation of the picture signal by the charging of a light-dependent capacity and the subsequent discharge across a secondary-emission discharge path." Preliminary experiments are described.

4024. Electron Scanners for producing Images of the Structure of Surfaces and Thin Films.—Knoll & Theile. (*See* 4111.)

4025. On the Problem of Electrical Image Storage [General Survey, including the Behaviour of Insulating or Quasi-Insulating Mosaics and of Semiconducting Mosaics].—G. Krawinkel, W. Kronjäger, & H. Salow. (*T.F.T.*, Supp. No., Nov. 1938, Vol. 27, pp. 527–533.)

For the writers' work on semiconductor pick-up tubes *see* 1065 of March and back reference. In spite of the apparently greater promise presented by the use of semiconductors, researches on the insulating type are still in progress.

4026. Survey of Television Pick-Up Devices.—K. McIlwain. (*Journ. of Applied Phys.*, July 1939, Vol. 10, No. 7, pp. 432–442.)

4027. On the Mode of Action of Image Pick-Up Tubes and on Increasing Their Sensitivity [Survey of Methods of Increasing the Energy of the Released Photoelectrons, by means of an Accelerating Voltage, etc: leading to the Image-Converter Cathode-Ray Scanner (Lubszynski & Rodda, Knoll) and to the German P.O. Type, 1938 Berlin Exhibition (Fig. 5)].—W. Heimann. (*T.F.T.*, Supp. No., Nov. 1938, Vol. 27, pp. 541–544.) *See* also Knoll, 216 of January.

4028. An Iconoscope Pre-Amplifier [raising Output Current (of a Few Tenths of a Microampere) to give One-Quarter Volt, before Mixing, Clipping, & Transmission Processes: employing Five Type 1851 Valves].—A. A. Barco. (*RCA Review*, July 1939, Vol. 4, No. 1, pp. 89–107.)

4029. The Analysis of Two Types of Video Amplifier.—Epstein & Donley. (In paper dealt with in 3912, above.)

4030. A Coloured Light Relay [for Colour Television, etc: Exhibited at 1938 Berlin Show: Combination of Polariser, Kerr Cell, "Stepped" Wedge (Mica), & Analyser].—G. Otterbein. (*T.F.T.*, Supp. No., Nov. 1938, Vol. 27, pp. 550–551.)

4031. A New Large-Surface Light Relay for Intensity, Colour, or Plane-of-Polarisation Control.—M. von Ardenne. (*T.F.T.*, June 1939, Vol. 28, No. 6, pp. 226–231.)

"A short time ago the writer described cathode-ray projection apparatus with 'light-relay screens,' in which the electro-optical effect in the direction of an electric field in eccentric crystals is utilised, and in special arrangements is doubled by the artifice of a reflecting backing to the crystal layer [2432 of June & back reference, and 3633 of September]. The screen units there described can also, as will be shown in the present paper, be set up as simple relays for the intensity, colour, or plane-of-polarisation control of large quantities of light . . . The simplicity of the large-surface light relay, its remarkably small capacity per square centimetre of relay surface, and its universal applicability, should soon make it an indispensable component for the solution of many problems in electro-optics." The fact that the electro-optical effect on which the device functions depends only on the magnitude of the potential difference, and not on the field strength, enables the thickness of the crystal layer to be increased so as to reduce the total capacity, this increase being limited by the increase in double refraction and in absorption by the zinc blende. Experiments seem to indicate that thicknesses up to 5 mm are reasonable for pure crystals: such a thickness would bring the capacity down to 1.5 picofarad per sq. cm. This means, for instance, that relay surfaces several decimetres square could have building-up times very small compared with the framing-period, or even the line-period, of modern television.

Apart from television, the relay as an intensity control has applications to photography and stroboscopy. As a colour control its chief field will be television in colour (for Otterbein's suggested use of the Kerr cell for this purpose *see* 4030, above). Its extremely good optical efficiency makes it very promising for this, and by using it as described on p. 230 (bottom of r-h column) a complete coincidence of the three coloured lines on the screen can be attained, so that there is no flicker of colour and no colour grating to be seen on close viewing. The writer refers to his previous paper (4443 of 1938) in which he showed the improvement in the impression made on the viewer by colour in television even on the present-day frequency band: the new device should therefore have an immediate interest. The principle of the use as a colour-control is illustrated in Fig. 1 (bottom diagrams) and Fig. 5. Since the cell produces approximately the same phase differences for the various rays of the visible spectrum (Schramm, 1876 of 1936), the use of a "path-difference" plate is necessary to introduce the required dependence on wavelength. By suitable choice of material, thickness, and orientation for this plate the "ground" colour (*i.e.* the colour when the cell is free from applied voltage) can be set at any point in the range of polarisation colours of the 1st to the *n*th order.

As regards the use of the screen as a control of plane of polarisation (Fig. 1, centre), the application to stereoscopic television will be dealt with later by Gröttrup: the device should also be valuable in film projection.

4032. INVESTIGATIONS ON THE FARADAY EFFECT IN TRANSPARENT MEDIA [Measurement of State of Polarisation of Light which has passed through Kerr Cell filled with Nitrobenzol in Magnetic Field: Agreement with Theory: Value of Temperature Coefficient of Verdet Constant of Nitrobenzol].—F. Gabler. (*Naturwiss.*, 28th April 1939, Vol. 27, No. 17, p. 274.)

4033. A THEORY OF ELECTRIC POLARISATION, ELECTRO-OPTICAL KERR EFFECT, AND ELECTRIC SATURATION IN LIQUIDS AND SOLUTIONS.—A. Piekara. (*Proc. Roy. Soc.*, Series A, 1st May 1939, Vol. 171, No. 944, p. S 43: abstract only.)

4034. THE IMPORTANCE OF THE [Mechau] PICTURE-STABILISING PROJECTOR AS A TELEVISION FILM TRANSMITTER [for Use with Disc Scanner, Farnsworth Image-Dissector, or Iconoscope].—F. Schröter. (*T.F.T.*, Supp. No., Nov. 1938, Vol. 27, pp. 534–537.) A summary was dealt with in 1985 of May.

4035. APPLICATION OF MOTION-PICTURE FILM TO TELEVISION [Special Requirements for Intermittent-Movement Projector used with Iconoscope: an Experimental "Rocking Mirror" Projector using Continuously Moving Film: etc.].—E. W. Engstrom, G. L. Beers, & A. V. Bedford. (*RCA Review*, July 1939, Vol. 4, No. 1, pp. 48–61.) The intermittent-movement system "is considered best at present." *Cf.* 4034, above.

4036. THE INFLUENCE, ON THE FORM OF TELEVISION SIGNALS, OF THE CONDITIONS OF EMPLOYMENT OF THE EQUIPMENT [Broadcasting, Running Commentaries, etc: Interlacing or No Interlacing (also, Interlacing of Order higher than 2): DuMont System: French Thomson-Houston Signals: etc.].—J. L. Delvaux. (*Bull. de la Soc. franç. des Élec.*, July 1939, Vol. 9, No. 103, pp. 559–568.)

4037. A TELEVISION PICK-UP VAN OF THE R.P.F.—G. Weiss, D. von Oettingen, & G. Turetschek. (*T.F.T.*, Supp. No., Nov. 1938, Vol. 27, pp. 544–549.)

Including an appendix on the calculation of the background-noise reduction factor (*see* the section on the amplifier, on p. 545) and another on the "pulse-generating tube" (Fig. 11) and its use for checking the performance of the amplifier.

4038. TELEVISION PICK-UP OVER TELEPHONE CABLE PAIRS [from Madison Square Gardens to Radio City].—(*Bell Lab. Record*, June 1939, Vol. 17, No. 10, p. 313.) For Clark's paper on such a use of telephone cable *see* 1369 of 1935. *Cf.* also Padel, 2862 of July.

4039. WIDE-BAND CABLES [Preliminary Considerations on Field-Strength Distribution within a 0.25 cm Copper Conductor at Frequencies up to 4 Mc/s, Optimum Ratio of Diameters as Function of Specific Resistance of Conductors, Kilometric Attenuations: German Types, with Spiral Styroflex or Frequenta Disc Insulation].—H. Decker. (*T.F.T.*, Supp. No., Nov. 1938, Vol. 27, pp. 551–554.)

4040. CONCENTRIC PAIRS FOR HIGH FREQUENCIES [French P.O. Television Cables: Methods of Measurement, particularly for Irregularities: Interpretation of Results obtained in Factory and on Laid Cables: Distortionless Transmission possible over Very Great Distances: Limit more probably set by Other Causes such as Imperfect Matching of Repeaters].—L. Parcé. (*Ann. des Postes, T. et T.*, May & June 1939, Vol. 28, Nos. 5 & 6, pp. 362–389 & 433–450.)

4041. MEASURING THE TRANSMISSION SPEED OF THE COAXIAL CABLE.—J. F. Wentz. (*Bell Lab. Record*, June 1939, Vol. 17, No. 10, pp. 309–313.)

4042. HIGH-DEFINITION TELEVISION.—P. Mertz. (*Journ. of Applied Phys.*, July 1939, Vol. 10, No. 7, pp. 443–446.)

4043. PROBLEMS OF TELEVISION TRANSMISSION [General Account].—P. C. Goldmark. (*Journ. of Applied Phys.*, July 1939, Vol. 10, No. 7, pp. 447–454.)

4044. TELEVISION RECEIVING AND REPRODUCING SYSTEMS [General Account].—E. W. Engstrom. (*Journ. of Applied Phys.*, July 1939, Vol. 10, No. 7, pp. 455–464.)

4045. DISCUSSIONS ON "THE LONDON TELEVISION SERVICE" AND "THE MARCONI-E.M.I. TELEVISION SYSTEM."—Macnamara & Birkinshaw: Blumlein, Browne, Davis, & Green. (*Journ. I.E.E.*, Aug. 1939, Vol. 85, No. 512, pp. 271–279.) *See* 637 of February.

4046. PRODUCTION PROBLEMS OF TELEVISION.—D. K. Woolfe Murray. (*Journ. Television Soc.*, No. 1, Vol. 3, 1939, pp. 1–7.)

4047. PROBABLE INFLUENCES OF TELEVISION ON SOCIETY.—D. Sarnoff. (*Journ. of Applied Phys.*, July 1939, Vol. 10, No. 7, pp. 426–431.)

4048. THE B.B.C. QUESTIONNAIRE ON POPULARITY OF TELEVISION ITEMS.—(*Journ. Television Soc.*, No. 1, Vol. 3, 1939, p. 31.)

4049. A TELEVISION-DEMONSTRATION SYSTEM FOR THE NEW YORK WORLD'S FAIR [including the "Flask" Receiver with Front-Excited Screen, giving Bright Image for Daylight Viewing].—D. H. Castle. (*RCA Review*, July 1939, Vol. 4, No. 1, pp. 6–13.)

4050. MAGNETIC TELEVISION RECEIVER.—W. T. Cocking. (*Wireless World*, 29th June 1939, Vol. 44, pp. 602–604, and 6th, 13th, & 20th July 1939, Vol. 45, pp. 13–17, 35–40, & 57–62.)

4051. The Philips Large-Screen Television Receiver [giving Projection Picture 18″ × 14½″].—P. W. S. Valentine. (*Journ. Television Soc.*, No. 1, Vol. 3, 1939, pp. 7–11: Discussion pp. 12–14.)

4052. Servicing in Relation to Television Receivers.—D. W. Parratt. (*Journ. Television Soc.*, No. 1, Vol. 3, 1939, pp. 14–25: Discussion pp. 25–28.)

4053. Steering by Television [Some Systems of applying Television to Direction Finding and Blind Landing, already Subject of Patents].—(*Wireless World*, 20th July 1939, Vol. 45, pp. 51–52.)

4054. The Electrical Transmission of Pictures [Short Historical Survey (from Bain, 1842, and Caselli, 1855): Modern Facsimile Systems, including the Use of Constant-Amplitude, Variable-Length Signals for Half-Tone Pictures, to avoid the Fading Effects on Amplitude Modulation: Limits of Speed & Detail: Synchronising Systems: Applications].—L. V. Kamenarovic. (*Alta Frequenza*, July 1939, Vol. 8, No. 7, pp. 444–464.)

4055. On the Theory of Electronic Semiconductors [Discussion of Discrepancies between Wilson's Theory and Recent Experiments: Proposed Extension of Wilson's Theory].—B. R. A. Nijboer. (*Proc. Phys. Soc.*, 1st July 1939, Vol. 51, Part 4, No. 286, pp. 575–584.) For Wilson's theory *see* 1932 Abstracts, p. 108.

4056. The Mean Free Path of Electrons in Polar Crystals [Calculations: Mobility: Comparison with Experimental Materials on Semiconductors and Substances showing Photoconductivity].—H. Fröhlich & N. F. Mott. (*Proc. Roy. Soc.*, Series A, 7th July 1939, Vol. 171, No. 947, pp. 496–504.)

4057. Optical Properties of the Alkali Metals [with Curves].—H. B. Briggs. (*Bell Lab. Record*, July 1939, Vol. 17, No. 11, pp. 343–346.) For previous work *see* 221 of January.

4058. Electrical Conductivity of Alkali Halide Crystals with Additional Colouring Matter [does Not Obey Ohm's Law, which is Valid when Colouring Matter is Removed].—Z. Gyulai. (*Zeitschr. f. Physik*, No. 1/2, Vol. 113, 1939, pp. 28–35.)

4059. On the Internal Photoelectric Effect [Considerations of Electron Energy Levels in Crystals of Alkaline Halides, and Experimental Verification by Method of "Optical Probes"].—P. S. Tartakovsky. (*Bull. de l'Acad. des Sci. de l'URSS*, Série Physique, No. 5/6, 1938, pp. 689–694: in Russian, with short French summary.)

4060. The Quantum Equivalent in the Case of the Primary Current of the Internal Photoeffect [only holds for a Relatively Small Spectral Region at the Maximum of the Current Curve].—F. Hlučka. (*Zeitschr. f. Physik*, No. 1/2, Vol. 113, 1939, pp. 56–60.)

4061. Studies in Photoelectric Photometry: a Photoemissive Cell specially designed for High-Precision Measurements [Causes of Imperfectly Proportional Response: Design of Cell giving Proportional Response, with Disc Cathode and Guard-Ring: Testing, Response, Potential Characteristics, etc.].—G. A. Boutry & P. Gillod. (*Phil. Mag.*, Aug. 1939, Series 7, Vol. 28, No. 187, pp. 163–184.) *Cf.* 3305 *bis* of 1938.

4062. Thallium-Sulphide Photocells with "Positive" Photoeffects [Electron Passage from Metal into Semiconductor] of the Barrier Layer [Spectral Sensitivity over Very Wide Range, Maximum at 1μ: Sensitivity to X-Rays 65 Times greater than That of Selenium Cells: Efficiency 0.537%].—B. T. Kolomiec [Kolomiets]. (*Bull. de l'Acad. des Sci. de l'URSS*, Série Physique, No. 5/6, 1938, pp. 689–704: in Russian, with English summary.) For previous work *see* 4489 of 1938.

4063. Two Remarkable Examples of Non-Additivity of Photoelectric Effects with Simultaneous Luminous Flux [with Thallofide and Selenium Cells: Effect of Superposition of Continuous Intense Illumination on Feeble Modulated One].—G. Liandrat. (*Comptes Rendus*, 10th July 1939, Vol. 209, No. 2, pp. 101–103.) For Schönwald's paper on the measurement of photoelectric currents in semiconductors, in which the non-additive effects were first announced, *see* 1933 Abstracts, p. 107.

4064. The Wavelength Variation of the Nuclear Photoeffects: with Appendix —The Radioactive Isotopes of Selenium. —W. Bothe & W. Gentner. (*Zeitschr. f. Phys.*, No. 1/2, Vol. 112, 1939, pp. 45–64.)

4065. The Selenium Photoelement: II— Current/Voltage Relations [Behaviour in Stationary Electric Field: Effect of Type of Exciting Light, Light Current Density, and Temperature: Probable Existence of Two Zones in Photoelement].—A. Becker. (*Zeitschr. f. Physik*, No. 11/12, Vol. 112, 1939, pp. 629–647.) For I *see* 631 of 1938.

MEASUREMENTS AND STANDARDS

4066. A New [Free-Wave] Method of Determining the Properties of Dielectrics at Centimetric Wavelengths.—M. Velasco & G. L. Hutchinson. (*Proc. Phys. Soc.*, 1st July 1939, Vol. 51, Part 4, No. 286, pp. 689–694.)

"The method is effectively a measurement of the real and imaginary parts of the dielectric constant . . . The real part gives rise to the induction current in the medium, whilst the imaginary part is related to the conduction current and hence to the absorption." The secondary wave "reflected" from a slab of the dielectric material interferes with the incident parallel beam. The amplitude produced at a distance from the slab, of known area and thickness (eqn. 6), can be measured and, with the positions of the interference maxima and minima, gives sufficient data for determination of the dielectric properties. The method "requires only relatively small amounts of the substance and is particularly applicable to measurements on solid materials . . . it has been employed at a wavelength of 12 cm to measure the refractive indices and the absorption coefficients of some common laboratory substances. The results obtained are given and briefly discussed."

4067. MEASUREMENTS OF CURRENTS, VOLTAGES, AND IMPEDANCES DOWN TO 20 CM WAVELENGTH.—M. J. O. Strutt & K. S. Knol. (*Hochf:tech. u. Elek:akus.*, June 1939, Vol. 53, No. 6, pp. 187–195.)

Indicating instruments for voltage measurements in the short-wave range are dealt with in § I. The circuits of three known diode voltmeters are shown in Fig. 1, the arrangement for determining the diode characteristics in Fig. 2. Equivalent circuits for these voltmeters are derived (Fig. 5) and their properties discussed, with particular reference to their impedance when connected to other apparatus (formulae 1.5, 1.6). Fig. 6 shows a short-wave diode designed for use in these circuits. Indicating instruments for currents in the decimetric wave range, and their calibration, are discussed in § II. Fig. 7 sketches a compensation hot-wire milliammeter working by air expansion, Fig. 8 thermojunctions in a high vacuum. For comparison and calibration of current meters down to 20 cm wavelength an instrument is described whose scheme is shown in Fig. 9 and practical development in Figs. 10–12, in which particular care is taken that the same currents, or currents in a known relation, shall flow through the two instruments under comparison. The hot-wire milliammeter of Fig. 7 is regarded as the standard instrument for all waves down to 20 cm, and the thermojunctions are compared with it. All are calibrated with direct current; it is found that alternating currents of wavelength 20 cm can be measured with errors of less than 2%.

Methods of measuring resonance curves and impedances (§ III) are based on the circuit of Fig. 13, which includes a diode voltmeter; relative calibration is carried out with the aid of a thermojunction (§ II). Fig. 16 shows the apparatus for wavelengths of about 1 m, Fig. 18 two oscillators for the ranges 1–2 m and 2–4 m respectively. The circuit of Fig. 13 and its use are described in detail. A circuit for the absolute calibration of a diode voltmeter with a calibrated thermojunction (Fig. 19) is described in § IV; Fig. 20 shows the apparatus for wavelengths of about 4 m. For wavelengths of about 1 m the circuit of Fig. 21 is suitable; it includes a parallel-wire circuit with wires whose cross-section is shown in Fig. 22. The diode voltmeter moves along these wires, making slip contacts with the halves of the split outer casing. The measurements are found to show that, with the diodes used, the electron transit time has no effect on the rectification for wavelengths down to 1 m.

4068. A BRIDGE FOR SEPARATING THE COMPONENTS OF TRAVELLING WAVES [by which the Incident, Reflected, and Standing Waves of Voltage on a Transmission Line may be Separated for Simultaneous and Independent Measurement: Other Applications].—H. E. Hartig & C. Brunetti. (*Elec. Engineering*, Aug. 1939, Vol. 58, No. 8, pp. 345–346.)

4069. MEASURING THE TRANSMISSION SPEED OF THE COAXIAL CABLE.—J. F. Wentz. (*Bell Lab. Record*, June 1939, Vol. 17, No. 10, pp. 309–313.)

4070. THE EVALUATION OF OPEN AND CLOSED CIRCUIT MEASUREMENTS ON HOMOGENEOUS CABLES [Methods of Approximation: Their Validity].—F. Sommer. (*E.N.T.*, May 1939, Vol. 16, No. 5, pp. 127–134.)

Exact methods of derivation of cable constants from the fundamental equations are summarised in § I.1; Kaden's method of approximation for the evaluation of the constants (596 of 1937) is given in § I.2; the regions (Fig. 2) are investigated in which it can be applied to determine inductance, resistance, and capacity with an accuracy within 1%. A method of approximation for low frequencies is given in § I.3. In § II the usual circuits for open- and closed-circuit measurements are given; it is shown how the magnitudes entering into the approximation methods may be derived from the measured data. It is found that for most cables the approximate method can be used if the length of the cable is less than a quarter wavelength. The mathematical derivation of the formulae and approximations used is given in an appendix.

4071. SYSTEMATIC MEASUREMENTS OF HIGH RESISTANCES AT HIGH FREQUENCIES.—A. Bressi. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, Dec. 1938, Year 1, No. 4, pp. 21–30: in English.) The full Italian paper was dealt with in 4500 of 1938. For Viti's paper on the dynatron method extended to ultra-high frequencies *see* 4499 of 1938.

4072. PARALLEL-RESONANCE METHODS FOR PRECISE MEASUREMENTS OF HIGH IMPEDANCES AT RADIO FREQUENCIES, AND THEIR COMPARISON WITH THE ORDINARY SERIES-RESONANCE METHODS.—D. B. Sinclair. (*L'Onde Élec.*, June 1939, Vol. 18, No. 210, pp. 260–277: to be contd.) French version of the *Proc. I.R.E.* paper dealt with in 1619 of 1939.

4073. CORRECTION TO THE PAPER "CONTRIBUTION TO LEAKAGE CALCULATION WITH ASYMMETRICAL DISC WINDINGS" [Corrected Formulae].—Knaack. (*Arch. f. Elektrot.*, 14th June 1939, Vol. 33, No. 6, pp. 417–418.) *See* 3342 of August.

4074. A FREQUENCY-MEASURING ARRANGEMENT OF HIGH ACCURACY [within 1×10^{-4} for Frequencies 0.3–1500 kc/s: developed from the Grüneisen/Merkel "Standard Note Generator"].—H. O. Kneser & H. Knötzel. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 20, 1939, pp. 242–244.)

The principle of the method is to tune the "standard generator" (left-hand side of Fig. 1), either at its fundamental or at one of its harmonics, to the frequency under measurement, or one of its harmonics. The frequency of the "standard generator" is obtained from its variable-condenser reading by a semi-empirical formula, whose continued validity is checked before and after each measurement by comparison with a fixed standard frequency.

The variable "standard generator" is loosely but constantly coupled, through a resistance-coupled amplifier, to headphones or loudspeaker. The quartz-controlled standard-frequency generator *QS* is connected across the same amplifier: its single frequency is about 100 kc/s, while the frequencies of the "standard generator" are always below 20 kc/s. Audible combination tones are therefore produced with the fundamental quartz-controlled frequency only, so that zero combination tone indicates that the particular "standard generator" frequency is a simple fraction of the quartz-controlled frequency.

4075. FREQUENCY MEASUREMENTS CARRIED OUT BY THE E.I.A.R. CONTROL CENTRE AT SESTO CALENDE.—L. Sponzilli. (*U.R.S.I. Proc. of* 1938 *Gen. Assembly*, Vol. 5, Fasc. 1, 1938, pp. 230–235: in Italian, with French summary.)

4076. A DYNAMIC MEASUREMENT OF THE ELASTIC, ELECTRIC, AND PIEZOELECTRIC CONSTANTS OF ROCHELLE SALT [Measurement of Resonant Frequencies and Impedance of Vibrating Crystals: Difference from Statically-Measured Piezoelectric Constants is attributed to Finite Relaxation Time for Piezoelectric Elements].—W. P. Mason. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1141: abstract only.)

4077. ANOMALY OF THE SPECIFIC HEAT OF POTASSIUM DIHYDROGEN PHOSPHATE AT THE UPPER CURIE POINT [Result bearing on Dielectric Properties of Rochelle Salt and Other Substances].—W. Bantle & P. Scherrer. (*Nature*, 10th June 1939, Vol. 143, p. 980.)

4078. THE DEPENDENCE OF INTERNAL FRICTION IN METALS ON GRAIN SIZE.—Randall, Rose, & Zener. (*See* 4009.)

4079. NEW CONTRIBUTION TO THE QUESTION OF TIME-KEEPING IRREGULARITIES OF CLOCKS IN GREENWICH AND GÖTTINGEN.—H. Gockel. (*Zeitschr. f. Physik*, No. 3/4, Vol. 113, 1939, pp. 188–191.)

The parallelism of discontinuities in time-keeping of clocks in Greenwich and Göttingen, found in a former paper (2039 of May and back references) is also shown here by the examination of further data, which may indicate that a common external cause is acting on the clocks.

4080. RECENT COMPARISONS OF THE ELECTRICAL UNITS OF VARIOUS COUNTRIES [Standard Ohms and Weston Cells].—A. Pérard, M. Romanowski, & M. Roux. (*Comptes Rendus*, 3rd July 1939, Vol. 209, No. 1, pp. 23–25.)

4081. ADJUSTMENT OF ELECTRICAL UNITS [Reasons against Change in the Value of the Ohm: Preferable to change Ampere and Volt].—P. Vigoureux. (*Nature*, 1st July 1939, Vol. 144, pp. 32–33.)

4082. THE USE OF GAS-FILLED LAMPS AS HIGH-DISSIPATION, HIGH-FREQUENCY RESISTORS, ESPECIALLY FOR POWER MEASUREMENTS [Hydrogen-Filled Lamp possessing unusually Great Heat-Dissipating Ability and Other Advantages].—E. G. Linder. (*RCA Review*, July 1939, Vol. 4, No. 1, pp. 83–88.)

4083. EXPERIMENTS ON AN ELECTRONIC WATTMETER.—L. Vallese. (*Alta Frequenza*, July 1939, Vol. 8, No. 7, pp. 427–443.)

Author's summary:—"Some types of valve wattmeter are reviewed [Mallet, 1933 Abstracts, p. 634, and back reference: Neri, 1934 Abstracts, p. 317: Pierce, 2756 of 1936, and Wey, 4229 of 1937], and then the working of one of these types, based on the properties of valves with two control grids [heptodes: the type is that of the last two references above] is examined from the point of view of the conditions for maximum sensitivity and minimum error. The theoretical conclusions agree with the experimental results.

"The circuit diagram of the arrangement is given [two heptodes are used, the microammeter giving a differential reading], together with the calibration curve and the results of tests on the effects of variation of the frequency, of the power factor, and of the anode and heating voltages, on the indications of the wattmeter. Some diagrams illustrate the results of measurements of the no-load losses of a modulation transformer at constant voltage and varying frequencies." It is concluded that with careful use the wattmeter should prove a very valuable laboratory instrument.

4084. THE PRODUCTION AND MEASUREMENT OF SMALL VOLTAGES AT RADIO FREQUENCIES [for the Calibration of the Attenuators of Signal Generators].—A. Pinciroli. (*Alta Frequenza*, June 1939, Vol. 8, No. 6, pp. 363–376.)

Author's summary:—"Some of the methods proposed for the calibration of r.f. attenuators are described. A method is then given which from various points of view seems to present advantages over these: it is based on a special property of the characteristic curves of valves [in the region of negative grid bias]. The method is simple, for it replaces r.f. measurements by the measurement of direct currents, and the apparatus is cheap: in fact, only a precision d.c. microammeter is required. It is shown that the correct application of the method allows r.f. voltages to be calibrated over a wide range of amplitudes (from a few tenths of a microvolt to some tenths of a volt) with a precision within about 1%." The simple circuit is shown in Fig. 5, while an improved circuit, with two valves in opposition, is given in Fig. 6: here both poles of the condenser are insulated and symmetrical with respect to earth.

Analysis (eqns. 9–16) shows that the method can be applied to amplitude-modulated r.f. currents as well as unmodulated; a correction can be made for the error introduced by high values of modulation percentage. In the final section the various methods are compared: the one which is judged to be the most accurate (Fig. 3, Section 2c: a thermojunction/millivoltmeter combination is used) has certain disadvantages over the proposed method, such as delicacy, square-law indication instead of linear, and greater limitations as to frequency (although by using a special thermojunction with separate heating, and a short very fine wire for the standard resistance, the frequency error can be kept low): the writer's method "is utilisable even at the highest radio frequencies."

4085. A New Type Vacuum Thermoelement [Rugged, Sensitive, Single-Junction: primarily for Investigations on High-Velocity Molecular Beams].—I. Amdur & H. Pearlman. (*Review Scient. Instr.*, June 1939, Vol. 10, No. 6, pp. 174–175.)

4086. An Electrostatic Analyser for Complex Waves of Small Amplitude.—J. C. Prescott. (*Journ. I.E.E.*, Aug. 1939, Vol. 85, No. 512, pp. 302–308: Discussion pp. 309–313.) A summary was dealt with in 2056 of May.

4087. A Precise High-Frequency Inductometer [Settings are Reproducible to within 1/100th Microhenry and 1/10 000th Ohm].—L. E. Herborn. (*Bell Lab. Record*, July 1939, Vol. 17, No. 11, pp. 351–352.) For use with the 5-megacycle bridge (2699 of 1937) if the inductance to be measured is below 10 μH, when the use of a capacitance standard is rendered difficult by the size of the condenser necessary.

4088. Notes on the Dynamics of Instruments [Interpretation of Fundamental Equations to facilitate Use of Instruments in Practical Applications to Unusual Conditions: *e.g.* Noise-Meters and Other Measuring Instruments for Unsteady Loads].—T. A. Rich. (*Gen. Elec. Review*, July 1939, Vol. 42, No. 7, pp. 311–316.)

4089. Instruments incorporating Thermionic Valves, and Their Characteristics.—James, Polgreen, & Warren. (*Journ. I.E.E.*, Aug. 1939, Vol. 85, No. 512, pp. 242–262: Discussions pp. 262–271.) *See* 3283 of August.

4090. Portable High-Frequency Transmission-Measuring Set [up to 150 kc/s: Type 30A].—F. R. Dickinson. (*Bell Lab. Record*, Aug. 1939, Vol. 17, No. 12, pp. 385–389.)

4091. Frequency Compensation for A.C. Instruments [by Use of a Closed *R*, *C*, *L* Circuit as a Frequency-Dependent Series Resistance: Its Calculation, and the Resultant Loss in Sensitivity].—C. H. Sturm. (*Funktech. Monatshefte*, June 1939, No. 6, pp. 161–163.)

4092. Millivoltmeters with Swinburne Temperature Compensation.—Ya. S. Averbukh. (*Izvestiya Elektroprom. Slab. Toka*, No. 4, 1939, pp. 39–46.) Design formulae and practical suggestions. *See* also Brooks, 660 of 1937.

4093. Plan for a Measuring Apparatus for Very Intense Continuous Currents: the Kiloammeter and the Magnemeter, *and* New Device for the Measurement of Intense Continuous Currents [Flexible Solenoid (to surround Conductor) and Fluxmeter].—R. Fortrat: B. Tsaï. (*Journ. de Phys. et le Radium*, April 1939, Series 7, Vol. 10, No. 4, pp. 190–194: June 1939, No. 6, p. 105 S.) For Tsaï's device *see* also *Recherches et Inventions*, July 1939, Vol. 19, No. 279, pp. 145–148.

4094. On the Possibility of Realising a New Magnetometric Arrangement [primarily for Measurement of the Earth's Magnetic Field: Compensation Method based on Wiedemann-Matteucci Effect in Ferromagnetic Wire traversed by Alternating Current].—G. Valle & G. Tribulato. (*La Ricerca Scientifica*, June 1939, 10th Year, No. 6, pp. 569–571.)

4095. An Instrument for Magnetic Measurements [Fluxometer based on Uniformly Rotating Disc Armature].—G. Cocci & R. Sartori. (*L'Elettrotecnica*, 10th April 1939, Vol. 26, No. 7, pp. 292–297.)

4096. Measurements on the Dielectric Constant of CO_2 at 25°, 50°, and 100° C up to 1700 Atmospheres.—Michels & Kleerekoper. (*Physica*, July 1939, Vol. 6, No. 7, pp. 586–590.)

SUBSIDIARY APPARATUS AND MATERIALS

4097. Post-Acceleration in Cathode-Ray Tubes.—Rogowski & Thielen. (*Arch. f. Elektrot.*, 14th June 1939, Vol. 33, No. 6, pp. 411–417.)

The action of the post-acceleration lens (placed after the deviating plates, Fig. 3) is illustrated diagrammatically in Figs. 3–8 and investigated theoretically. The authors find and verify experimentally that "to reach accurate conclusions on post-acceleration, the post-acceleration field should not be replaced by an electrical double layer (*cf.* Schwartz, 3627 of September). The axially symmetrical form of the distribution of the accelerating field must be taken into full account and the radial forces considered. In this case the special result is found that, for sufficiently high accelerating voltage, the sensitivity of a cathode-ray tube *increases* with the accelerating voltage, with simultaneous reversal of the direction of deviation. Normal sensitivity can indeed be reached without accelerating voltage, and under certain circumstances, surpassed. Experiments show that this deduction is correct and it is thus to be expected that the new result will have a favourable effect on the construction of sensitive cathode-ray oscillographs."

4098. The Attainment of High Recording Speeds with a Sealed-Off, purely Electrostatic Cathode-Ray Tube [*i.e.* with Electrostatic Focusing and Deflection: Adequate Blackening of Photographic Plate at Speed of 14 000 km/s with Anode Voltage of 15 kV, Sensitivity 0.07 mm/V].—Katz & Westendorf. (*Zeitschr. f. tech. Phys.*, No. 7, Vol. 20, 1939, pp. 209–212.)

4099. Electron-Optical Theory of the Plane Ideal Condenser.—Herzog. (*Zeitschr. f. Physik*, No. 3/4, Vol. 113, 1939, pp. 166–187.)

"The paths of charged particles passing through an ideal plane condenser, whose field is homogeneous up to its edge and sharply bounded, are calculated and discussed. In addition to the deviation, there is an effect similar to that of a cylindrical lens; the positions of the foci and principal points are determined." Energy dispersion, the optimum use of the condenser when the ray enters obliquely (Fig. 8), the combination of two fields to produce a lens with a symmetrical ray path (Fig. 9) and the corresponding caustic (Fig. 10), and the spot distortion in cathode-ray tubes (Fig. 12) are discussed. The application to mass spectroscopy is also considered.

4100. A Mechanical Model for Electron Motion in a Uniform Magnetic Field.—Rose. (*See* 3952.)

4101. An Electron Lens Type of Beta-Ray Spectrometer, *and* An Electron [Magnetic] Spectrograph.—Witcher & others: Harris. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1135: p. 1135: abstracts only.)

4102. Electron Optics [General Account: Determination of Refractive Fields, Electron Paths, First-Order Image Properties, Aberrations, etc.].—Ramberg & Morton. (*Journ. of Applied Phys.*, July 1939, Vol. 10, No. 7, pp. 465–478.)

4103. The Aperture Error of Electrostatic Tube Lenses [Tube Arrangement with Two Cylindrical Electrodes for Measurement of Aperture Error: Error Constants as Function of Ratio of Cylinder Diameters: Minimum Error with Equal Diameters].—Gundert. (*Zeitschr. f. Physik*, No. 11/12, Vol. 112, 1939, pp. 689–690.)

4104. Experiments, Calculations, and Results on the Problem of the Resolving Power of the Super-Microscope.—von Borries & Ruska. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 20, 1939, pp. 225–235.)

For other recent work *see* 4544 of 1938 and 3292/4 of August, and back references. The paper deals with the calculation, and experimental checking, of the diffraction, aperture, and chromatic errors; the influence of these on the resolving power; the calculation of resolving power from the first two types of error; the influence of the ray voltage on the resolving power; and a comparison of the writers' results with the tests and calculations of other workers (von Ardenne's results—*see* 710 of February and back references—are criticised at considerable length: *cf.* also von Ardenne, 4105, below). There are about 30 literature references.

4105. Remarks on the Magnitude of the Chromatic Error in the Electron Microscope [with Results affecting Theory of "Raster" Microscope].—von Ardenne. (*Zeitschr. f. Physik*, No. 3/4, Vol. 113, 1939, pp. 257–259.)

Some results given in a former paper (*see* first three lines of 4076 of 1938) are corrected; lower values are found for the chromatic error. A rule for the design of the electron microscope is given, which reduces the importance of the chromatic error; it is that "the objective aperture should be varied so that the principal faults, particularly the chromatic image error, are adjusted to cancel the diffraction error." This requires real stops of very fine bore; to produce them it is necessary to develop special methods of boring. The theoretical superiority of the "raster" microscopes with radiation passing through the object (1667 of April and back references) is found to be considerably decreased by the corrections here made.

4106. Efficiency of the Electron Shadow Microscope [Comparison with "Raster" Microscope] and an X-Ray Shadow Microscope [with Resolving Power Independent of Thickness of Object Film].—von Ardenne. (*Naturwiss.*, 14th July 1939, Vol. 27, No. 28, pp. 485–486.) *See* Boersch, 3715 of September, for the electron shadow microscope, *and* von Ardenne, 4076 of 1938 (and 1667 of April) for the "raster" microscope; *also* 4105, above.

4107. Questions of Intensity and Resolving Power of the [Magnetic] Electron Microscope [Current Density in Final Image: Illumination Time and Resolving Power: Screen Brightness and Resolving Power: Adjustment of Illumination System to a Small Object Load: Ultra-Microscopy].—von Ardenne. (*Zeitschr. f. Physik*, No. 11/12, Vol. 112, 1939, pp. 744–752.)

4108. On the Possibility of the Examination of Living Substances with Electron Microscopes.—von Ardenne. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 20, 1939, pp. 239–242.)

Author's summary:—"The minimum 'object-loading' [ionising load, measured by C/cm^2, representing the number of electrons passing through each unit of surface during the period of irradiation] in electron microscopes of ordinary type is estimated, for a resolving power of 10^{-5} mm, at $2\text{–}5 \times 10^{-4}$ C/cm^2. The critical electron-loading of living substances is from 1 to 1½ orders of magnitude smaller, according to the nature of the object; so that at the moment the possibility of investigating living material by the electron microscope [both ordinary type and "raster" type] must be denied, unless other micro-organisms or parts of organisms can be found possessing higher powers of resistance to ionisation, or a smaller resolving power than 10^{-5} mm is accepted. It appears, however, not to be impossible that the gap will be filled, in the not distant future, by improved 'loading' conditions, on lines indicated in the paper" [increased accelerating voltage; improvement of the electron lens; diminution of the weakening effect, on the current density, of the screen image; improvement of the properties of the photographic layer].

4109. Single-Crystal Fluorescent Screens and Super-Microscopy [Ultra-Violet and Electron Microscopy].—von Ardenne. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 20, 1939, pp. 235–239.)

Author's summary:—Single-crystal screens of activated zinc sulphide for super-microscopes are described, which give a resolving power of about 5μ for ultra-violet light and of about 10μ for electrons. By the use of these screens it should, as shown in the paper, be possible to obtain an important gain in intensity in the screen image and also, indirectly, in photographic recording.

4110. THE EFFECT OF ELECTRON BOMBARDMENT ON THE ELECTRICAL CONDUCTIVITY OF ZINC BLENDE CRYSTALS, *and* DIELECTRIC ANOMALIES OF ZINC BLENDE CRYSTALS.—Distad. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1146 : p. 1147 : abstracts only.)

4111. ELECTRON SCANNERS FOR PRODUCING IMAGES OF THE STRUCTURE OF SURFACES AND THIN FILMS.—Knoll & Theile. (*Zeitschr. f. Physik*, No. 3/4, Vol. 113, 1939, pp. 260–280.)

The electron-optical methods for the production of images of surfaces and thin films by stationary and movable electron beams are shortly reviewed. The fundamental scheme of the movable beam system, the electron scanner, is shown in Fig. 1, the circuits of the scanning tube in Fig. 2. "The structural image is reproduced by connecting the signal plate [a metal plate carrying the object, on which the electron beam of a cathode-ray tube impinges], through an amplifier, to the control electrode of a tube giving the image, whose electron beam moves in synchronism with the beam scanning the object. The 'electrical image signal' thereby arises in the current circuit of the secondary electrons emitted from the object, so that the structure image arises from differences in the secondary emission in the object surface. In the case of badly-conducting or insulating objects, an image of the resistance or capacity distribution of the object is superposed on this secondary-emission image. The resolving power for very small structural distances (geometrical resolving power) and for very small structural differences (contrast resolving power) is discussed. Possible applications of the structural images formed by the electron scanner are illustrated by some examples." Fig. 9 shows a scanning tube for investigating the structure of an insulating object, Fig. 10 a tube for use with samples of material in compact or powder form at various temperatures, Figs. 11–16 reproductions of various experimental results.

4112. ELECTRON DIFFRACTION STUDIES OF VERY THIN FILMS : I—STRUCTURE OF VERY THIN FILMS [Atoms and Molecules can move over Surface of Supporting Foil and be drawn together into Crystals of Considerable Size].—Germer. (*Phys. Review*, 1st July 1939, Series 2, Vol. 56, No. 1, pp. 58–71.)

4113. EMISSION OF ELECTRONS FROM COPPER, SILVER, AND ALUMINIUM ON THE IMPACT OF HIGH-VELOCITY IONS.—Grassmann. (*Ann. der Physik*, Series 5, No. 5, Vol. 35, 1939, pp. 465–472.)

4114. INITIAL PERFORMANCE OF THE 60-INCH CYCLOTRON OF THE WILLIAM H. CROCKER RADIATION LABORATORY, UNIVERSITY OF CALIFORNIA.—Lawrence & others. (*Phys. Review*, 1st July 1939, Series 2, Vol. 56, No. 1, p. 124.)

4115. THE TECHNIQUE OF HIGH-INTENSITY BOMBARDMENT WITH FAST PARTICLES [produced by 37-Inch Cyclotron].—Kurie. (*Review Scient. Instr.*, July 1939, Vol. 10, No. 7, pp. 199–205.)

4116. THEORY AND REALISATION OF CONTINUOUS GENERATORS OF VERY HIGH VOLTAGE EMPLOYING A DUST CURRENT.—Morand & Raskin. (*Comptes Rendus*, 31st July 1939, Vol. 209, No. 5, pp. 297–299.)

4117. RECENT PROGRESS IN THE PRODUCTION OF HIGH TENSIONS BY CURRENTS OF ELECTRIFIED PARTICLES—Pauthenier. (*Bull. de la Soc. franç. des Élec.*, Aug. 1939, Vol. 9, No. 104, pp. 638–646.)

4118. PRESENT-DAY TECHNIQUE OF VACUUM APPARATUS FOR VERY HIGH VOLTAGES.—Matricon. (*See* 3956.)

4119. A GRID CONTROLLED IONISATION [Vacuum] GAUGE. — Montgomery & Montgomery. (*Journ. Franklin Inst.*, June 1939, Vol. 227, No. 6, pp. 851–853.) Referred to in 2037 of 1938.

4120. THE DESIGN OF AN ACCURATE MCLEOD GAUGE.—Rosenberg. (*Review Scient. Instr.*, April 1939, Vol. 10, No. 4, pp. 131–134.)

4121. AN IMPROVED STOPCOCK SUBSTITUTE.—Parks & Carritt. (*Review Scient. Instr.*, April 1939, Vol. 10, No. 4, p. 148.)

4122. FATIGUE PHENOMENA OF LUMINESCENT MASSES IRRADIATED BY ELECTRONS.—Grotheer. (*Zeitschr. f. Physik*, No. 9/10, Vol. 112, 1939, pp. 541–559.)

Fatigue phenomena for substances such as zinc silicate are investigated (apparatus scheme Fig. 1) for the cases when the irradiating electron beam is stationary (§ III), periodically extinguished (§ IV), and moving (§ V). A theory of the phenomena is given, based on assumptions as to the movements of the metallic atoms in the luminescent substance, and formulae are deduced for the emission of light and for the transparency. The theory is tested experimentally. It is found that "the fatigue/time law is approximately exponential. For long duration of the electron irradiation, a non-zero final value of the illumination density is reached, which indicates that a regeneration process (recovery) is acting in the opposite direction to the fatigue. The weakening of the illumination density as a result of the separation of the metal from its combination in the luminescent substance by the electron beam can be determined separately and introduced as a correcting term in the fatigue curve. The results of experiments with periodically extinguished and movable electron beams could be completely accounted for by the results for a stationary beam."

4123. SENSITISATION OF PHOSPHORESCENT ZINC SULPHIDE BY THE ACTION OF RED RADIATION [Effect on Decay of Luminescence in Presence of Fe & Cu].—Saddy. (*Comptes Rendus*, 10th July 1939, Vol. 209, No. 2, pp. 93–95.)

4124. Luminescent Materials [General Survey of Physical Bases of Excitation, Atoms & Electrons in Crystals, etc: Properties of Particular Luminescent Materials].—Leverenz & Seitz. (*Journ. of Applied Phys.*, July 1939, Vol. 10, No. 7, pp. 479–493.)

4125. The Metastable Character of the "Attachment Positions" in Crystal Phosphors [Explanation from Model of Phosphor Structure].—Schön. (*Naturwiss.*, 23rd June 1939, Vol. 27, No. 25, p. 432.) For previous work *see* 1674 of April.

4126. Fluorescence Investigations on Secondary Uranium Minerals [Classification into Strongly-, Weakly-, and Non-Luminescent Materials]. — Meixner. (*Naturwiss.*, 30th June 1939, Vol. 27, No. 26, p. 454.)

4127. The Fluorescence Spectra of the Rare Earths in Artificial Fluorites, and Their Explanation.—Chatterjee. (*Zeitschr. f. Physik*, No. 1/2, Vol. 113, 1939, pp. 96–114.)

4128. The Blue Fluorescence of Natural Silicates in Ultra-Violet Light, and Synthetic Experiments on Silicate Fluxes including Bivalent Europium.—Haberlandt & Köhler. (*Naturwiss.*, 28th April 1939, Vol. 27, No. 17, p. 275.)

4129. Fluorescent Power of Uranine Solutions as a Function of Their Concentration in H^+ Ions. — Boutaric & Roy. (*Comptes Rendus*, 17th July 1939, Vol. 209, No. 3, pp. 162–164.)

4130. The Detection of Single Positive Ions, Electrons, and Photons by a Secondary-Electron Multiplier. — Allen. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1133: abstract only.)

4131. The Mean Free Path of Electrons in Polar Crystals.—Fröhlich & Mott. (*See* 4056.)

4132. Electron Diffraction Study of Copper Oxides.—Dunholter & Kersten. (*Journ. of Applied Phys.*, July 1939, Vol. 10, No. 7, pp. 523–524.)

4133. Symposium on Semiconductors and Dry-Plate Rectifiers. — Joffe, Davydov, Pisarenko, & others. (*Bull. de l'Acad. des Sci. de l'URSS*, Série Physique, No. 5/6, 1938, pp. 614–688: in Russian, with short English summaries.)

4134. On the Theory of Electronic Semiconductors.—Nijboer. (*See* 4055.)

4135. Theory of the Ferromagnetism of the Semiconductor.—Miyahara. (*Zeitschr. f. Physik*, No. 3/4, Vol. 113, 1939, pp. 247–256.), Theory based on Wilson's model of a semiconductor (1932 Abstracts, p. 108) and Slater's theory of ferromagnetism (4330 of 1937).

4136. The Theory of Crystal Rectifiers [Criticism of Existing Theories: Alternative Theory: Agreement with Experiment].—Mott. (*Proc. Roy. Soc.*, Series A, 1st May 1939, Vol. 171, No. 944, pp. 27–38.) A summary was dealt with in 2563 of June.

4137. Electronic States at the Surfaces of Crystals: IV—The Activation of Adsorbed Atoms by Surface Electrons [Effect of Surface Electrons can only become appreciable in Semiconductors or Insulators].—Goodwin. (*Proc. Camb. Phil. Soc.*, July 1939, Vol. 35, Part 3, pp. 474–484.)

4138. Theory of Electrical Breakdown in Ionic Crystals: II [Electron and Lattice Vibrations: Formula for Breakdown Field Strength: Calculation from Optical Properties of Dielectric, Dielectric Constant, and Molecular Volume: Results for Various Materials agree with Experiments].—Fröhlich. (*Proc. Roy. Soc.*, Series A, 19th July 1939, Vol. 172, No. 948, pp. 94–106.) A summary was referred to in 3765 of September.

4139. Theory of the Electrical Breakdown of Solid Insulators [Criticism of Fröhlich's Theory].—Franz. (*Naturwiss.*, 23rd June 1939, Vol. 27, No. 25, pp. 433–434.) For Fröhlich's paper see 3503 of 1937. Results of a "more exact calculation" are here also shortly indicated.

4140. The Temperature Dependence of the Electrical Breakdown in Single Crystals [Steep Decrease in Breakdown Strength with Falling Temperature].—Buehl & von Hippel. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1122: abstract only.)

4141. The Behaviour of Amorphous and Crystallised Quartz in the Electrostatic Field [Experimental Results as a Contribution to the Explanation of the Phenomena inside a Solid Dielectric].—Gayling von Altheim. (*Ann. der Physik*, Series 5, No. 5, Vol. 35, 1939, pp. 417–444.)

4142. The Dielectric Properties of Dielectrics Dispersed in Water, and Anomalous Dispersion in Bound (Oriented) Water [Anomaly may Originate in Multimolecular Layer of Oriented Water Molecules at Interphases: Bearing on Dielectric Properties of Soil, Hygroscopic Electric Insulators, etc.].—Fricke. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, pp. 1141: abstract only.)

4143. Ionic Mobility in Solid Dielectrics [Calculations on Assumption that Ionic Mobility is controlled by Combined Resistance of Viscosity, Elasticity, and Solid Friction: Finite Contribution to Dielectric Constant due to Ions & Loss Factor under Alternating Electric Stress]. — Gemant., (*Journ. of Applied Phys.*, July 1939, Vol. 10 No. 7, pp. 508–513.)

4144. Statistics of Space-Charges in Gliding Sparks [Gleitfunken : Töpler's "Spreading Discharges"] : III—Discharges along Dielectric Surfaces with Adsorption of the Charge Carriers. — Müller-Strobel. (*Arch. f. Elektrot.*, 14th June 1939, Vol. 33, No. 6, pp. 347–366.)

4145. Thermal Instability of Dielectrics under Continuous Voltages when the Conductivity is Dependent upon the Field Strength [Theory]. — Gemant. (*Journ. Franklin Inst.*, July 1939, Vol. 228, No. 1, pp. 79–90.) For previous work on a.c. voltages *see* 2972 of July.

4146. Dielectric Loss in Ceramics at High Frequencies.—Bogoroditski & Friedberg. (*Bull. de l'Acad. des Sci. de l'URSS*, Série Physique, No. 3, 1938, pp. 289–297 : in Russian, with short German summary.) For previous work *see* 685 of 1938.

4147. Experiments with Steatite containing Added Metallic Oxides [Improved Baking Properties of Powdered Talc with Added Oxide, particularly BaO].—Nakazi. (*Rep. of Rad. Res. in Japan*, [dated] Dec. 1938, Vol. 8, No. 3, pp. 101–110 : in English.)

4148. Polystyrene : Its Electrical and Mechanical Characteristics [Practical Hints, including Cementing, Bending, etc.].—Riddle. (*QST*, Aug. 1939, Vol. 23, No. 8, pp. 32–33.) "Known by various trade names, the most familiar of which is 'victron'".

4149. The Electric Strength of Fibrous Glass [Breakdown Voltage for A.C. Voltage Higher than for D.C : Electric Strength increases Linearly with Pressure (up to 5 Atmos.) : Satisfactory Strength up to 350° C : Increased Density would be Desirable : etc.].—Gemant & Glassow. (*Elec. Engineering*, Aug. 1939, Vol. 58, No. 8, pp. 341–345.)

4150. The "Days" of the Plastic Materials and Synthetic Resins, Paris, 10th–18th June 1939.—Blain. (*Génie Civil*, 8th July 1939, Vol. 115, No. 2, pp. 36–39 : to be contd.) Summaries of some of the principal lectures.

4151. The Impact Testing of Plastics.—Burns & Werring. (*Bell T. System Tech. Pub.*, Monograph B-1120, 14 pp.)

4152. "Handbuch der künstlichen plastischen Massen" [Patent Survey : Book Review].—Kausch. (*Zeitschr. V.D.I.*, 8th July 1939, Vol. 83, No. 27, p. 820.)

4153. "Elektrische Stossfestigkeit" [Dielectric Strength against Surges : Book Review].—Strigel. (*Zeitschr. f. tech. Phys.*, No. 7, Vol. 20, 1939, p. 223.)

4154. Sorption of Water by Organic Insulating Materials [and Its Effect on the Dielectric Constant].—Taylor. (*Bell Lab. Record*, Aug. 1939, Vol. 17, No. 12, pp. 370–372.) By "sorption" is meant the combined effect of adsorption and absorption.

4155. Negative Power Factors in Air Capacitors [in Atmosphere of High Humidity], *and* An Explanation of the Negative Power Factors in Air Capacitors.—Astin : Curtis & Astin. (*Phys. Review*, 15th March 1939, Series 2, Vol. 55, No. 6, p. 594 : p. 594 : abstracts only.) *See* also 2109 of May.

4156. Nature of Energy Losses in Air Capacitors at Low Frequencies [60–1000 c/s : Two-Electrode, Guard-Ring, and Three-Electrode Rotating-Plate Types : Contribution of a Surface Layer to Power Factor : Effect of Nonhomogeneous Field : etc.].—Astin. (*Journ. of Res. of Nat. Bur. of Stds.*, June 1939, Vol. 22, No. 6, pp. 673–695.)

4157. Electrolytic Condensers : Principle, Characteristics, and Special Features [including a Denunciation of the Fallacy that a Condenser is the Better, the Smaller Its Power Factor].—(*Ann. des Postes, T. et T.*, July 1939, Vol. 28, No. 7, pp. 532–542.) "Other things being equal, a condenser with a loss coefficient of 8% will give a filtering practically identical with that given by one of 2%, and the former will have a higher breakdown point and a longer life." Contrast Chrétien, 4576 of 1938, quoted in an editorial comment on the present paper.

4158. Electrochemical [Electrolytic] Condensers [Survey : Nature of Dielectric : Choice of Metal : Applications outside Wireless : etc.].—André. (*Bull. de la Soc. franç. des Élec.*, Aug. 1939, Vol. 9, No. 104, pp. 647–675.)

4159. Reconditioning of Insulating Oils by Activated Alumina.—Housley. (*Elec. Engineering*, April 1939, Vol. 58, No. 4, Transactions pp. 172–178.)

4160. The Dielectric Strength of Benzene & Heptane [Dielectric Strengths of Pure Liquids depend primarily on Nature of Electrode Surface].—Dornte. (*Journ. of Applied Phys.*, July 1939, Vol. 10, No. 7, pp. 514–522.)

4161. A New Method of Determining the Properties of Dielectrics at Centimetric Wavelengths.—Velasco & Hutchinson. (*See* 4066.)

4162. Systematic Measurements of High Resistances at High Frequencies.—Bressi. (*See* 4071.)

4163. Non-Wire Constant Resistances [Discussion of Resistances chiefly of American Manufacture].—Vaganov. (*Izvestiya Elektroprom. Slab. Toka*, No. 2, 1939, pp. 59–63.)

4164. The Locus Curves of the Resistance of Coils with Iron Cores, taking into consideration the Frequency-Dependent Hysteresis Loss.—Braun. (*See* 3981.)

4165. The Dispenser Cathode : a New Type of Thermionic Cathode for Gaseous Discharge Tubes.—Hull. (*See* 3961.)

4166. The Use of Gas-Filled Lamps as High-Dissipation, High-Frequency Resistors, especially for Power Measurements.—Linder. (*See* 4082.)

4167. Cold-Cathode Gas-Filled Tubes as Circuit Elements [as Relay: as Rectifier: as Voltage Regulator: Comparison with Ignitron & Thyratron: Applications (Photocell Relay, Phase Control, Square-Wave & Relaxation Oscillators, Remote Control of Receivers, & Selective Ringing)].—Ingram. (*Elec. Engineering*, July 1939, Vol. 58, No. 7, Transactions pp. 342–346 and 347.)

4168. The Electrical Protection of Cold-Cathode Luminous Discharge-Tube Installations. — Barlow. (*Journ. I.E.E.*, Aug. 1939, Vol. 85, No. 512, pp. 295–301: Discussion pp. 309–312.)

4169. "Die Glimmröhre in der Technik" [the Many Practical Applications of the Glow-Discharge Tube: Book Review].—Nentwig. (*Zeitschr. f. tech. Phys.*, No. 7, Vol. 20, 1939, p. 223.)

4170. The Transition from Glow Discharge to Arc [Experiments on Glow Discharges in Air, Oxygen, Nitrogen, and Hydrogen, with Various Combinations of Electrode Materials: Evidence for Hypothesis of Electron Emission in Arcs under High Surface Field Strengths].—Fan. (*Phys. Review*, 15th April 1939, Series 2, Vol. 55, No. 8, pp. 769–775.) For criticisms *see* Cady, *ibid.*, 1st July, Vol. 56, No. 1, pp. 123–124.

4171. Transition Forms between Arc and Glow Discharge in Series of Sparks.—Kaiser & Wallraff. (*Zeitschr. f. Phys.*, No. 34, Vol. 112, 1939, pp. 215–222.)

4172. Normal and Sub-Normal Conditions and Distributions of the Glow Discharge at Plane Semiconductor Electrodes of Heated Glass.—Wolf. (*Zeitschr. f. Physik*, No. 1/2, Vol. 112, 1939, pp. 96–106.)

4173. Limiting Currents in a Ring Discharge: *also* Electron and Potential Distributions near the Anode of a Mercury Discharge: The Effect of Wall Charge on the Progressive Breakdown in Long Discharge Tubes: Discharges between a Stationary and a Moving Electrode: *and* The Positive Column of the Nitrogen Arc.—Smith: Smith & Hartman: Dietrich: Snoddy & Beams: Stone, Compton & Lamar. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, pp. 1144 and 1145: abstracts only.)

4174. Heat Conduction in the High Pressure Column [is chiefly due to Ionic Diffusion].—Rompe & Schulz. (*Zeitschr. f. Physik*, No. 1/2, Vol. 113, 1939, pp. 10–17.)

4175. Theory of the Cathode Discharge Portions of a Low-Pressure Discharge: I—The Drop Space [Extension of Rogowski's Theory of Glow Discharge: Formula for Density in Drop Space and for Cathode Drop: Values of Coefficient of Electron Liberation due to Incident Ions]: II—The Glow.—Weizel, Rompe, & Schön. (*Zeitschr. f. Phys.*, No. 5/6, Vol. 112, 1939, pp. 339–349: No. 1/2, Vol. 113, 1939, pp. 87–95.)

4176. Expression of the Anode Voltages and the Currents taken from the Mains by an Ionic Valve [particularly Mercury-Vapour Rectifiers or D.C./A.C. Converters, for Polyphase Working: Treatment by Laurent's Analogy with Rotating Collectors].—Kouskoff. (*Rev. Gén. de l'Élec.*, 15th April 1939, Vol. 45, No. 15, pp. 461–470.)

4177. Investigations on the Internal Oscillations of Low-Voltage Arcs [Experimental Material: Disturbance of Discharge by Introduction of Probe: New Arrangement for Moving Probe: Oscillations probably due to Movement of Positive Space Charge].—Funk & Seeliger. (*Zeitschr. f. Physik*, No. 3/4, Vol. 113, 1939, pp. 203–217.)

4178. Autoelectronic Emission in Metal Arcs.—Huxford, Eskin, & Jones. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1146: abstract only.)

4179. Variation in Breakdown Voltage of Molecular Gases due to Irradiation.—Fucks & Schumacher. (*Zeitschr. f. Physik*, No. 9/10, Vol. 112, 1939, pp. 605–613.)

4180. Breakdown-Voltage Change [due to Ultra-Violet Irradiation] for Spark Gaps met with in Practice [in Air at Atmospheric Pressure: Investigation of Rogowski & Fucks Equation]. — Fucks & Bongartz. (*Zeitschr. f. tech. Phys.*, No. 7, Vol. 20, 1939, pp. 205–209.)

4181. The Definition of the Sparking Potential.—Loeb. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1121: abstract only.)

4182. Luminescent Probe in a Gaseous Discharge, *and* On the Hysteresis of an Alternating Current Electric Discharge.—Fabrikant: Granovsky & Merzloukhova. (*Comptes Rendus* (*Doklady*) *de l'Acad. des Sci. de l'URSS*, No. 9, Vol. 22, 1939, pp. 570–572: pp. 573–575.)

4183. Luminescent Zones in Front of Glow-Discharge Cathodes [due to Excited Atoms from Cathode].—Sporn. (*Zeitschr. f. Phys.*, No. 5/6, Vol. 112, 1939, pp. 278–304.) Closer investigation of zones described by Güntherschulze & Keller in 1932.

4184. The Doppler Effect and Field Distribution in the Hailer Canal-Ray Tube.—Sherwin & Dempster. (*Phys. Review*, 15th March 1939, Series 2, Vol. 55, No. 6, pp. 582–583.)

4185. On Large Metal Electrodes situated in a Gaseous Discharge Plasma.—Askinazi. (*Journ. of Tech. Phys.* [in Russian], No. 24, Vol. 8, 1938, pp. 2107–2117.)

Trouble is often experienced with apparatus such as mercury rectifiers in which the discharge takes place within a metal body. In the present paper the effect of gaseous discharge on insulated metal surfaces is discussed, and methods are indicated for calculating the potential of these surfaces and the longitudinal currents flowing in them. A report is also presented on experiments made to verify the theoretical conclusions reached.

4186. A Heavy-Current Hydrogen Discharge Tube.—Garton. (*Proc. Phys. Soc.*, 1st May 1939, Vol. 51, Part 3, No. 285, pp. 551–552: Demonstration.)

4187. "Rhythmatic" Control Apparatus [Demonstration: Relays operated by Four Frequencies (800 . . . 1500 c/s) superposed on Power Network: Each with Six Different Time Values, giving 24 Selective Operations]. —(*Engineering*, 11th Aug. 1939, Vol. 148, p. 182.)

4188. Increasing the Range of Tripping [Telephone-Type] Relays [Sensitivity increased by Enlarged Pole Piece: etc.], *and* Time Characteristics of the U-Type Relay. — Stacy: Swenson. (*Bell Lab. Record*, July 1939, Vol. 17, No. 11, pp. 353–355: Aug. 1939, No. 12, pp. 379–383.)

4189. The New Receiving Relay [Estoup Type A] of the P.T.T. Administration for Long-Distance Cable Telegraphy.—Estoup. (*Ann. des Postes, T. et T.*, May 1939, Vol. 28, No. 5, pp. 321–361.)

4190. An Equivalent Circuit of the Polarised Relay.—Livshits. (*Izvestiya Elektroprom. Slab. Toka*, Nos. 4 & 5, 1939, pp. 33–38 & 37–43.)

A discussion of the operation of a polarised relay (Fig. 1) the armature of which is tuned to oscillate at a certain frequency; since the oscillations of the armature are caused by the winding circuit, the movement of the armature produces in its turn a resonance effect in this circuit. Equations (35) and (41) are derived, determining respectively the movement of the armature and the balance of the e.m.fs and voltage drops in the winding circuit. On the basis of these equations an equivalent circuit (Fig. 3) is derived. The theoretical results obtained have been checked experimentally.

4191. Heating of Point Contacts with Constant Current Load [Calculations].—Avramescu. (*Arch. f. Elektrot.*, 14th April 1939, Vol. 33, No. 4, pp. 261–268.)

4192. Erratum: "An Automatic Stabiliser Circuit."—Rogers. (*Review Scient. Instr.*, July 1939, Vol. 10, No. 7, p. 219.) *See* 2556 of June.

4193. Discussion on "The Moving-Coil Voltage Regulator."—Norris. (*Journ. I.E.E.*, July 1939, Vol. 85, No. 511, pp. 133–142.) *See* 4605 of 1938.

4194. Concerning Thermionic Regulation of Direct-Current Generators [Quantitative Estimation of Importance of Sources of Possible Instability: Application to Amplifier Method and Galvanometer/Photocell Method].—Danforth. (*Review Scient. Instr.*, July 1939, Vol. 10, No. 7, pp. 211–217.)

4195. Vibrators [giving H.T. for Car Receivers, etc., from L.P. Accumulator].—Cazaly. (*Wireless World*, 29th June 1939, Vol. 44, pp. 594–596.)

4196. Portable Transmitter Power Supply.—Dent. (*Wireless World*, 6th July 1939, Vol. 45, pp. 5–7.)

4197. On the Question of the Use of Aluminium as Cable-Sheath Material. — Czempiel & Haase. (*AEG-Mitteilungen*, July 1939, No. 7, pp. 347–353.)

4198. The Permeability of Magnetic Metals in the Region of High [and Ultra-High] Frequencies [Measurements for Commercial Iron and Pure Nickel].—Möhring. (*Hochf: tech. u. Elek:akus.*, June 1939, Vol. 53, No. 6, pp. 196–199.)

Previous measurements of the permeability of iron are summarised in § I: the variation with frequency which they give is shown as a curve in Fig. 1. The present measurements (§ II) extend over a frequency range 0.1–150 Mc/s; the method employed is the measurement of the error shown by thermojunction current meters with heating elements made of the material under investigation. The theory is given for the cases of low and high current density due to current penetration depending on the skin effect; in the experimental arrangement (Fig. 2) the current meter under test is placed between two standard instruments. Results in the form of curves (Figs. 5–11) are given for commercial iron and pure nickel. The permeability is found to vary with the frequency and to tend to the limit unity in the centimetric-wave range. For constant frequency, the permeability of both materials is found to increase with the current strength.

4199. The Approach to Saturation of Iron and Nickel: *also* Susceptibility Measurements of Cu/Fe Alloys in Fields from 0–40 000 Gauss: Ferromagnetic Anisotropy in Ni/Fe Alloys near Ni_3Fe: Investigations of Ferromagnetic Impurities in Metals: *and* The Isotopic Constitution of Iron and Chromium.—Kaufmann: Bitter & Kaufmann: Grabbe & McKeehan: Constant & Formwalt: Nier. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, pp. 1142 and 1143: abstracts only.)

4200. A Magnetic Study of the Iron/Nickel/Aluminium System.—Sucksmith. (*Proc. Roy. Soc.*, Series A, 7th July 1939, Vol. 171, No. 947, pp. 525–540.)

4201. The Magnetoresistance of Nickel in Large Fields [Measurements : Agreement with Gerlach's Theory : Increase of Spontaneous Magnetisation by Magnetic Field without Saturation appearing].—Heaps. (*Phys. Review,* 1st June 1939, Series 2, Vol. 55, No. 11, pp. 1069–1071.)

4202. The Nuclei and the Propagation of Magnetisation Changes for Large Barkhausen Discontinuities [Oscillographic Measurement of Data of Wave of Magnetisation Change for Stretched Permalloy Wire : Determination of Critical Field Strength : Range of Validity of Döring's Nucleus Theory : etc.]—Haake. (*Zeitschr. f. Physik,* No. 3/4, Vol. 113, 1939, pp. 218–233.) *See* 2575 of 1938 and 1724 of April.

4203. The Magnetic Susceptibility of Nickel Chloride [Measurements : Use as Standard for Magnetic Measurements].—Nettleton & Sugden. (*Proc. Roy. Soc.,* Series A, 19th July 1939, Vol. 172, No. 948, pp. S 73–S 74 : abstract only.)

4204. A Magnetic Study of the Oxides of Chromium and Manganese.—Bhatnagar, Kapur, & Prakash. (*Current Science,* Bangalore, June 1939, Vol. 8, No. 6, pp. 253–254.)

4205. Experimental Study of Some Cases of Antiferromagnetism [Chromium Compounds].—Foëx & Graff. (*Comptes Rendus,* 17th July 1939, Vol. 209, No. 3, pp. 160–162.)

4206. On the Decomposition of the Elementary Moment of Ferromagnetic Substances, and the Gyromagnetic Phenomena, *and* Studies of the Magnetic Moment in Ferromagnetic Alloys : I—The Question of Activation and of the Elementary Moment.—Forrer. (*Journ. de Phys. et le Radium,* March 1939, Series 7, Vol. 10, No. 3, pp. 24 S–25 S : April 1939, No. 4, pp. 181–187.)

4207. Powder Patterns on Permalloy Crystals [show that Magnetostriction has Little Relation to the Patterns, Which are probably due to Polishing].—Shih & Chai. (*Phys. Review,* 15th June 1939, Series 2, Vol. 55, No. 12, p. 1265.)

4208. The Development of Magnetic Materials.—Morgan. (*Printed Paper of Inst. P.O. Elec. Eng.,* No. 168, 12 pp.)

4209. Study of the Oxidation of Magnetite : Variation of Velocity of Oxidation at the Curie Point.—Lille. (*Comptes Rendus,* 12th June 1939, Vol. 208, No. 24, pp. 1891–1893.)

4210. Modern Views on Magnetism [Theories of Paramagnetic Salts, Ferromagnetism, Paramagnetism in Metals].—(*Nature,* 17th June 1939, Vol. 143, pp. 1032–1033 : notes on Strasbourg Conference.)

4211. "Modern Magnetism" [Book Review].—Bates. (*Journ. Scient. Instr.,* July 1939, Vol. 16, No. 7, p. 237.)

4212. The Determination of Magnetic Properties in Different Parts of Very Large Objects.—Khalileev. (*Journ. of Tech. Phys.* [in Russian], No. 24, Vol. 8, 1938, pp. 2118–2125.)

In manufacturing ferromagnetic objects it is often necessary to determine their magnetic properties. In the present paper methods are indicated for determining with the aid of a portable electromagnet the distribution of inductance and the magnetising curve of large thin metal sheets.

4213. A General-Purpose Electro-Magnet [with Permendur Cores : for Magnetisation of Permanent Magnets of the Recent Alloys].—Chegwidden. (*Bell Lab. Record,* June 1939, Vol. 17, No. 10, pp. 319–320.)

4214. Collector-Ring Films : Formation and Influence.—Hessler & Savage. (*Gen. Elec. Review,* May 1939, Vol. 42, No. 5, pp. 192–197.)

4215. On the Special Solution of the Stability Problems in High-Speed Rotors : Influence of Frictional Forces on the Transition through Critical Velocities.—Kapitza. (*Journ. of Tech. Phys.* [in Russian], No. 2, Vol. 9, 1939, pp. 124–147.)

4216. New Methods of Testing Enamelled Wire.—Weh. (*Gen. Elec. Review,* May 1939, Vol. 42, No. 5, pp. 203–209.)

4217. The Elastic Properties of Thin Quartz Threads.—Reinkober. (*Physik. Zeitschr.,* 15th May 1939, Vol. 40, No. 10, pp. 385–386.)

4218. Reflectivities of Evaporated Metal Films in the Near and Far Ultra-Violet [Photographic Measurements].—Sabine. (*Phys. Review,* 1st June 1939, Series 2, Vol. 55, No. 11, pp. 1064–1069.)

4219. Measurement of the Reflective Power of Metallic Mirrors.—Burger & van Milaan. (*Physica,* May 1939, Vol. 6, No. 5, pp. 435–438 : in English.)

4220. Use of Latex Dry Adhesive for Kymograph Paper.—Pratt. (*Science,* 23rd June 1939, Vol. 89, pp. 590.)

4221. An Experiment in the Use of Hot Pressing of Non-Ferrous Metals for the Electrical Industry.—Perlin. (*Izvestiya Elektroprom. Slab. Toka,* No. 4, 1939, pp. 49–51.) In the manufacture of aluminium and brass components : it is stated that considerable reduction in cost can thus be obtained, especially in mass production.

STATIONS, DESIGN AND OPERATION

4222. FREQUENCY MODULATION FUNDAMENTALS.—Noble: Armstrong. (*QST*, Aug. 1939, Vol. 23, No. 8, pp. 11–15.) With bibliography of 8 items. Apart from Carson's 1922 paper, all these have been dealt with in 2550 of 1936; 2504 & 2953 of 1937; 464 & 922 of 1938; 2733 of July, and 3542 of September.

4223. "5 AND 10" FROM SHACK OR CAR [Mobile Ultra-Short-Wave Equipment].—Taylor. (*QST*, Aug. 1939, Vol. 23, No. 8, pp. 34–38.)

4224. FOREST SERVICE DEVELOPS BELL-RINGING RADIO DEVICE [operating at 30–40 Mc/s: Call System incorporated in Truly Portable, Dry-Battery-Operated Radio Equipment].—(*Journ. Franklin Inst.*, July 1939, Vol. 228, No. 1, p. 127: short note only.)

4225. GREAT LAKES RADIOTELEPHONE SERVICE [for Cargo Vessels and Pleasure Craft: including the Two-Tone A.F. Selective Call System].—Martin. (*RCA Review*, July 1939, Vol. 4, No. 1, pp. 32–47.)

4226. RADIO IN AVIATION: A GENERAL SURVEY, WITH SPECIAL REFERENCE TO THE ROYAL AIR FORCE.—Hecht. (*See* 3973.)

4227. TESTS ON THE SUBJECT OF RADIOCOMMUNICATION WITH SUBMERGED SUBMARINES.—J. Houtsmuller. (*Tijdschrift van het Nederlandsch Radiogenootschap*, March 1939, Vol. 8, No. 2, pp. 271–296: in Dutch.)

Author's summary, in English:—"This paper concerns a treatment of the electrical properties of sea-water and their influence on the absorption and length of radio waves. Reception and transmission on a submerged loop aerial are discussed, and a [mathematical] examination of the reflection at, and the refraction through, the surface of the water shows under what conditions it is possible for energy to be transferred into the air. The treatment includes a method of determining the most suitable wavelength for a certain depth [it is first shown that this optimum wavelength is proportional to the square of the depth of the submarine]. In an addendum the radiation of a submerged oscillator is calculated." The results of the theory are supported by experiments carried out at intervals between 1923 to 1930.

4228. TWO-WAY SPEECH BY WIRELESS [on One Wavelength].—Marro. (*Phil. Mag.*, Aug. 1939, Series 7, Vol. 28, No. 187, pp. 248–251.)

For previous work on the persistence of hearing and on frequencies of interruption at which the voice can be transmitted satisfactorily *see* 1249 of 1937 and back reference: *also* 1290 of March and back reference. According to the present paper, "transmission will occur at intervals of [*i.e.* during periods of] 1/16 000th sec., spaced at . . . intervals of equal duration, during which the receiver will come into action": thus the interrupting oscillator has a frequency of 8000 c/s, which represents an increase on the frequencies mentioned in previous papers. It is recommended that the calling and called stations should operate on different frequencies (*e.g.* 8000 & 12 000 c/s) The system is claimed to be very suitable for communication between war-ships and "may also prove of great service to the air force." Successful tests on a 100 m wave are mentioned.

4229. POLYPHASE BROADCASTING [Peak Power Output of Final Amplifier Valves reduced to Twice (perhaps 1½ Times) the Carrier Power instead of Usual 4 Times: Rotating Modulation Field obtained by 5-Element Vertical Aerial Array: Possibility of Super-Power Transmitters (1000–2000 kW) using Available Valves].—Byrne: Collins Radio. (*Elec. Engineering*, July 1939, Vol. 58, No. 7, Transactions pp. 347–350.) The system referred to 1861 of May.

4230. THE WIRE-BROADCASTING WALL SOCKET.—Klein. (*T.F.T.*, May 1939, Vol. 28, No. 5, pp. 202–205.)

In the early days of wire broadcasting the subscriber's wall socket was a simple affair, but now that one telephone line has to supply a number of subscribers all kinds of complications require to be dealt with: one receiver tends to act on another, the lead between line and receiver acts as an aerial, and so on. The wall socket has therefore become much more complex: the transformer has had to be transferred to it from the subscriber's separating filter, and a change-over switch (wire/radio) has been added. Experience has not yet shown whether a single-pole switch is satisfactory, so a double-pole one is provided on the new socket (DDa 38); but one pole can be short-circuited so that data may be acquired as to the efficiency of a single-pole type for future use, since cheapness is very important. Another addition is the provision of a means for inserting suitable resistances to adjust the voltage to the receiver to a suitable value. A further complication is caused by the fact that when a single-circuit receiver has to be catered for, its selectivity is so low that a special wall socket seems to be called for, embodying an extra tuning circuit to improve the selectivity.

4231. THE SYNCHRONOUS [Common-Wave] OPERATION OF BBC TRANSMITTERS.—Varley. (*World-Radio*, 18th & 25th Aug. 1939, Vol. 29, pp. 12–13 & 18–19.)

4232. THE DETERMINATION OF THE MOST FAVOURABLE SITE FOR A BROADCAST STATION ON 301.5 METRES IN HOLLAND.—Koomans. (*Tijdschrift van het Nederlandsch Radiogenootschap*, July 1938, Vol. 8, No. 1, pp. 257–267: in Dutch.) For van der Pol's preliminary work *see* 3030 of 1938.

4233. LINES FOR BROADCAST TRANSMISSIONS [including Wire Broadcasting: with Some Attenuation Curves, etc.].—Wolff. (*AEG-Mitteilungen*, Aug. 1939, No. 8, pp. 376–380.)

4234. EUROPEAN BROADCASTING CONFERENCE IN MONTREUX [List of Frequencies assigned to Broadcasting Stations by New Plan].—(*E.N.T.*, May 1939, Vol. 16, No. 5, pp. 149–153.)

4235. Ranges, Choice of Waves and Powers of Wireless Stations for Different Types of Service.—Lenz. (*Funktech. Monatshefte*, June 1939, No. 6, pp. 163–170.)

4236. A Modern Radiotelegraph Control Centre [66 Broad Street, New York City: remotely operating Transoceanic and Inter-City Stations representing 51 Transmitters & Receivers].—Rau & Brown. (*RCA Review*, July 1939, Vol. 4, No. 1, pp. 14–31.)

4237. Monitoring Rack of Small Design for Wireless/Landline Installations.—Barkow & Künzel. (*T.F.T.*, June 1939, Vol. 28, No. 6, pp. 209–219.)

GENERAL PHYSICAL ARTICLES

4238. Natural Electromagnetic Oscillations of a Cavity [in Perfectly Conducting Body], *and* Natural Electromagnetic Oscillations of Dielectric Spaces.—Jouguet: Borgnis. (*See* 3873 & 3874.)

4239. New Contributions to the Problem of Energy Transmission by Elementary Collision Processes [Deductions from Observations of Molecular Spectra in Cooled and Uncooled Hollow Cathodes].—Schüler & Haber. (*Zeitschr. f. Physik*, No. 9/10, Vol. 112, 1939, pp. 614–625.)

4240. A New Method of Determining *e/m* for Medium High Velocities [from Motion of Electrons in Electric Field between Two Charged Coaxial Cylinders: Theory: Use of Radioactive Source emitting Continuous Velocity Spectrum of Electrons].—Aharoni. (*Nature*, 29th July 1939, Vol. 144, pp. 203–204.)

4241. A New Model of the Point Charge Electron and of Other Elementary Particles.—Stueckelberg. (*Nature*, 15th July 1939, Vol. 144, p. 118.)

4242. The Self-Energy and the Gravitation Field of an Electrical Point Charge [General Solution of Equations of Gravitational and Electromagnetic Field: Electron Radius: Results agreeing with Born-Infeld Results without Alteration of Maxwell's Equations].—Hönl & Papapetrou. (*Zeitschr. f. Physik*, No. 1/2, Vol. 112, 1939, pp. 65–85.)

4243. Diamagnetism of the Electron Gas: III [Calculation of Susceptibility of Gas in Box with Parallel Sides in Very Weak Field: Variation with Geometrical Shape of Box: Expectation of Abnormally Strong Diamagnetism for Stronger Fields].—Papapetrou. (*Zeitschr. f. Physik*, No. 9/10, Vol. 112, 1939, pp. 587–604.) For previous work *see* 701 of 1938 and back reference.

4244. Temperature of Electrons in Electric Field, and Calculation of Townsend's α.—Zaitzev. (*Comptes Rendus (Doklady) de l'Acad. des Sci. de l'URSS*, No. 3, Vol. 23, 1939, pp. 229–232: in English.)

4245. "La Mécanique ondulatoire des Systèmes de Corpuscles" [Book Review].—de Broglie. (*Ann. des Postes, T. et T.*, June 1939, Vol. 28, No. 6, pp. 492–494.)

4246. A Theory of Radiation [an Attempt to account for the Observed Properties of Radiation on Classical Lines, including the Capability of Ionising Atoms or Molecules].—Schott. (*Proc. Roy. Soc.*, Series A, 1st May 1939, Vol. 171, No. 944, pp. 1–26.)

4247. A Theory of Electric Polarisation, Electro-Optical Kerr Effect, and Electric Saturation in Liquids and Solutions.—Piekara. (*Proc. Roy. Soc.*, Series A, 1st May 1939, Vol. 171, No. 944, p. S 43: abstract only.)

4248. On the Nature of the Geometrical, Mechanical and Physical Entities: Importance of the Consideration of Symmetries and Dissymmetries, *and* Observations on the Above.—Bouthillon: Brylinski. (*Bull. de la Soc. franç. des Élec.*, July 1939, Vol. 9, No. 103, pp. 592–616: pp. 617–634.)

4249. Use of Surface States in Solids to Explain Activated Adsorption.—Pollard. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1147: abstract only.)

4250. An Experiment on Electromagnetic Induction by Linear Motion [E.M.F. induced in Circuit composed of Cylindrical Tube moving concentrically along Current-Carrying Conductor, and Stationary Leads to Inner & Outer Surfaces, is Independent of Permeability of Tube].—Cullwick. (*Journ. I.E.E.*, Aug. 1939, Vol. 85, No. 512, pp. 315–318.)

MISCELLANEOUS

4251. In Memoriam: Arthur E. Kennelly. (*Elec. Engineering*, Aug. 1939, Vol. 58, No. 8, p. 354.)

4252. A [Electrical] Device for Compounding Sine Functions.—Maxwell. (*Phys. Review*, 1st June 1939, Series 2, Vol. 55, No. 11, p. 1135: abstract only.)

4253. A Machine for the Rapid Summation of Fourier Series.—Beevers. (*Proc. Phys. Soc.*, 1st July 1939, Vol. 51, Part 4, No. 286, pp. 660–663: Discussion pp. 664–667.)

4254. "Die Differentialgleichungen der Technik und Physik" [Book Review].—Hort, Thoma. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 20, 1939, p. 246.)

4255. The Design of a Small Differential Analyser: *also* An Automatic Curve Follower for Use with the Differential Analyser: *and* A Reversible Head for the Automatic Curve-Following Device.—Lennard-Jones, Wilkes, & Bratt: Blackett & Williams: Williams. (*Proc. Camb. Phil. Soc.*, July 1939, Vol. 35, Part 3, pp. 485–493: pp. 494–505: pp. 506–511.)

4256. A RADIO SLIDE RULE [with Special Scales for Various processes, including Propagation over Plane Earth].—Morrison. (*Bell Lab. Record*, June 1939, Vol. 17, No. 10, p. 334.)

4257. CORROSION IN PLANT AND INSTRUMENTS FOR THE TRANSMISSION OF INTELLIGENCE [Survey].—Haehnel. (*E.T.Z.*, 15th June 1939, Vol. 60, No. 24, pp. 713–720.)

4258. SAFETY DEVICE SIGNALLING PASSAGE OF TRAINS, S.F.R. SYSTEM [for Repair Gangs, Level Crossings, etc.].—(*Bull. de la Soc. Franç. Radioélec.*, 4th Quarter 1938, Vol. 12, No. 14, pp. 106–111 : in French & English concurrently.)

4259. RECENT TUBE APPLICATIONS TO AUTOMOBILE MAKING [Trigger Circuits for Self-Centering Gauges, etc., etc.].—Powers. (*Electronics*, April 1939, Vol. 12, No. 4, pp. 12–15 and 63.)

4260. OLFACTORY ELECTRICITY [American "Electric Snout" for spotting Gas Leaks].—(*BEAMA Journal*, July 1939, Vol. 45, No. 25, p. 2 : paragraph only.)

4261. THE STRING METHOD AND THE ERECTION OF THE PALACE OF THE SOVIETS.—Davidenkov. (*Journ. of Tech. Phys.* [in Russian], No. 2, Vol. 9, 1939, pp. 160–164.)

Various methods are described which are being used in building the Palace of the Soviets in Moscow for checking by means of string tensiometers the deformations and movements taking place in the concrete foundations. Some of the methods are used for the first time.

4262. AN INDICATING ARRANGEMENT FOR SHORT-TIME MEASURING APPARATUS BASED ON TELEVISION EXPLORING-RAY SCANNING [for Echo-Sounding, Rotating-Beacon D.F., Frequency Control of Machines, Earthquake Recording, Relay-Contact Testing, etc.].—F. Winckel. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 20, 1939, pp. 244–246.)

The writer suggests that in echo-sounding, for instance, where times of perhaps 1/750th second have to be measured, the bulky arrangement of rotating glow-discharge lamp sometimes used might well be replaced by a stationary glow-discharge lamp of flat design scanned by a Nipkow disc or a mirror-screw scanner. A scale is fixed in front of the disc, parallel with the lamp, and graduated in phase angle, time, or metres of depth. If 1 mm on the scale is taken as readable, an accuracy of 1/7500th second would thus be obtainable with a disc of 35 cm diameter rotating at 50 r.p.s. A second lamp at the bottom of the disc can be used to register the variation of a second quantity.

A modern cathode-ray scanner gives the theoretical possibility of measuring times down to 10^{-7} second ; or even less, in view of the simpler requirements of time-measuring compared with those of television.

4263. APPLICATION OF A PROPORTIONAL AMPLIFIER TO X-RAY STRUCTURE ANALYSIS.—Isajev. (*Comptes Rendus (Doklady) de l'Acad. des Sci. de l'URSS*, No. 1, Vol. 23, 1939, pp. 42–44 : in English.) *See* also 4264.

4264. ON THE USE OF PROPORTIONAL AMPLIFIERS FOR X-RAY INTENSITY MEASUREMENTS.—Bibergal & others. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 9, 1939, pp. 215–221.)

4265. GENERATOR OF X-RAY FLASHES OF 1/1000TH SECOND FOR REGMOGRAPHY AND SERIOGRAPHY, *and* REGMOGRAPHY [New Röntgen-Cinematographic Technique].—Gilardoni : Cignolini.—(*Bollettino del Centro Volpi di Elettrologia*, English Edition, Dec. 1938, Year 1, No. 4, p. 95d : summary only.)

4266. DRYING WITH NEAR INFRA-RED RADIATION [for Lacquers, Enamels, etc : including Conveyor-Belt Equipment for Small Articles].—Ickis & Haynes. (*Gen. Elec. Review*, April 1939, Vol. 42, No. 4, pp. 145–149.)

4267. BODIES HOVERING FREELY IN AN ELECTRIC AND MAGNETIC FIELD [Theory shows to be Possible only if Diamagnetic Materials are present], *and* FREE HOVERING OF DIAMAGNETIC BODIES IN A MAGNETIC FIELD [shown with Bismuth and Carbon Particles].—Braunbek. (*Zeitschr. f. Physik*, No. 11/12, Vol. 112, 1939, pp. 753–763 : pp. 764–769.)

4268. THE ELECTROMAGNETIC LEVITATOR.—Bedford, Peer, & Tonks. (*Gen. Elec. Review*, June 1939, Vol. 42, No. 6, pp. 246–247.) For "floating suspension" and its possibilities for a new form of transport, *see* Kemper, 3069 of 1938.

4269. THE CINEMATOGRAPHIC METHOD OF STUDYING AND TIMING MANUAL OPERATION AS USED IN THE COMMUNICATION ELECTRICAL INDUSTRY IN THE U.S.A.—Jurgens. (*Izvestiya Elektroprom. Slab. Toka*, No. 3, 1939, pp. 52–57.)

4270. CINEMATOGRAPHY OF THE THOUSAND-MILLIONTH OF A SECOND : PRESSURE OF DETONATION.—Libessart, Culmann, & Séguin. (*Journ. de Phys. et le Radium*, May 1939, Series 7, Vol. 10, No. 5, pp. 72 S–73 S.)

4271. APPLICATION OF ELECTRICAL MEASURING METHODS TO THE DEGREE OF FINENESS OF POWDERED MATERIALS.—Lépingle. (*Génie Civil*, 24th June 1939, Vol. 114, No. 25, p. 534 : summary only.)

4272. RADIO-WAVE ABSORPTION AS A MEANS OF INVESTIGATION INTO MODERN ORGANIC STRUCTURE.—Cavallaro. (*Bollettino del Centro Volpi di Elettrologia*, English Edition, Oct./Dec. 1938, Year 1, No. 4, p. 97d : summary only.)

4273. ON THE POSSIBILITY OF THE EXAMINATION OF LIVING SUBSTANCES [Micro-organisms, etc.] WITH ELECTRON MICROSCOPES.—von Ardenne. (*See* 4108.)

4274. STUDIES IN PHOTOELECTRIC PHOTOMETRY : A PHOTOEMISSIVE CELL SPECIALLY DESIGNED FOR HIGH-PRECISION MEASUREMENTS.—Boutry & Gillod. (*See* 4061.)

Wireless Patents

A Summary of Recently Accepted Specifications

The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each

ACOUSTICS AND AUDIO-FREQUENCY CIRCUITS

509 613.—Voice-operated relay device for preventing instability in a loud-speaking telephone system.

L. E. Ryall. Application date 20th January, 1938.

AERIALS AND AERIAL SYSTEMS

506 518.—Short-wave transmitting aerial and feeder-system for radiating a wide range of side-bands, as in television.

Telefunken Co. Convention date (Germany) 28th November, 1936.

507 473.—Aerial couplings and feed-lines for ultra-short waves.

O. Bormann and J. Pintsch. Convention date (Germany) 15th September, 1936.

509 500.—Method of " earthing " television aerials and other high-frequency apparatus.

E. C. Cork and J. L. Pawsey. Application dates 17th December, 1937, and 8th March, 1938.

509 844.—Aerial arrangement for an installation where the feed-line or " down lead " must be taken to a point well above ground level.

Marconi's W.T. Co. and N. Wells. Application date 22nd January, 1938.

DIRECTIONAL WIRELESS

506 621.—D.F. " homing " receiver in which the pick-up voltage is periodically reversed in phase before being applied to a zero-centre indicator.

Telefunken Co. Convention date (Germany) 14th August, 1937.

506 630.—D.F. receiver in which the voltage from a pair of " crossed " frames is fed through separate amplifiers to the deflecting plates of a cathode-ray indicator.

Telefunken Co. Convention date (Germany) 11th December, 1937.

506 743.—Arrangement for applying volume control to a D.F. receiver, so as to keep the bearing-line " trace " within the limits of the indicator scale on the screen of a cathode-ray tube.

Marconi's W.T. Co. and R. J. Kemp. Application date 1st December, 1937.

507 181.—Direction-finder with an auxiliary frame aerial to compensate for quadrantal or like error.

Marconi's W.T. Co. and G. M. Wright. Application date 10th December, 1937.

507 461.—Direction-finder in which " night-error " is avoided by the use of four frame-aerials spaced around the circumference of a circle.

Telefunken Co. Convention date (Germany) 8th September, 1937.

507 587.—Direction-finder of the kind in which a visual indication of the bearing-line is given on the fluorescent screen of a cathode-ray tube.

Marconi's W.T. Co.; S. B. Smith; and R. J. Kemp. Application date 16th December, 1937.

507 754.—" Impulse " system of signalling designed to minimise interference, and to give highly-directional results.

W. S. Percival. Application date 16th November, 1937.

RECEIVING CIRCUITS AND APPARATUS

(*See also under Television*)

506 502.—Superhet receiver with push-button tuning for the more powerful stations and manual control for the others.

G. W. Johnson (communicated by Philco Radio and Television Corporation). Application date 26th October, 1937.

506 541.—Wave-band filter giving a sharp rise of attenuation on each side of the pass-band, without the use of piezo-electric crystals.

Marconi's W.T. Co. Convention date (U.S.A.) 30th November, 1936.

506 542.—Thermionic amplifier circuit arranged to eliminate the effect of fluctuations either in the load, or in the mains supply voltage.

Marconi's W.T. Co. Convention date (U.S.A.) 30th November, 1936.

506 543.—Construction of a multi-scale tuning-indicator, and means for selectively illuminating the scales.

Marconi's W.T. Co. Convention date (U.S.A.) 30th November, 1936.

506 603.—Local oscillator for a superhet arranged to cover a wide frequency range and to give a constant frequency-response throughout.

Hazeltine Corporation (assignees of J. F. Farrington). Convention date (U.S.A.) 16th February, 1937.

506 648.—Method of and means for illuminating the scale of a wireless tuning indicator.

Telefunken Co. Convention date (Germany) 1st December, 1936.

506 652.—High-frequency amplifiers stabilised by negative feed-back through a transmission line of the coaxial type.

Standard Telephones and Cables; R. M. Barnard; and A. H. Roche. Application date 1st December, 1937.

506 791.—Amplifying system with negative feed-back control through a "bridge" transformer network with four pairs of terminals.

Standard Telephones and Cables (communicated by Western Electric Co. Inc.). Application date 26th November, 1937.

506 881.—Resonator device coupled to an electronic device for generating or amplifying centimetre waves.

O. Bormann (J. Pintsch. Akt.). Convention date (Germany), 10th *September,* 1936.

506 977.—Coupling transformer between an aerial and a feed-line, designed to present a purely ohmic "loading" at resonance.

C. Lorenz Akt. Convention date (Germany) 10th August, 1937.

506 987.—Suppressing inductive interference in a wireless receiver by cutting the loud speaker out of action during the very short periods of each disturbance.

Philips' Lamp Co. Convention date (Germany) 21st September, 1937.

507 077.—A.V.C. system in which incoming signals are applied to one grid of a hexode valve, the gain-control voltage being developed across a second grid, and applied to a third.

R. E. Spencer. Application date 13th December, 1937.

507 220.—Wireless receiver fitted with means for increasing the degree of modulation of an incoming signal.

Marconi's W.T. Co. and O. E. Keall. Application date 10th December, 1937.

507 258.—Fixed condenser and trimmer, forming a "tuning unit" for a receiving set with push-button control.

Murphy Radio and D. N. Truscott. Application date 16th March, 1938.

507 305.—Means for controlling the driving motor for the automatic tuning system of wireless receiver.

Philips' Lamp Co. Convention date (Germany) 28th December, 1937.

507 586.—Tuned filter-circuit for a wireless receiver, designed to have a constant band-width over the whole of the tuning range.

Marconi's W.T. Co.; R. F. O'Neill; and J. D. Brailsford. Application date 16th December, 1937.

507 482.—Circuit arrangement for reducing the number of components normally required for automatic tuning control.

Telefunken Co. Convention date (Germany) 13th November, 1936.

507 605.—Arrangement of two inductance coils mounted inside a screening can for variable selectivity control.

Kolster-Brandes and L. G. Newman. Application date 17th December, 1937.

508 043.—Circuit arrangement for reducing the effective input capacity of a thermionic valve.

Telefunken Co. Convention dates (Germany) 28th December, 1936, *and 3rd April,* 1937.

508 580.—Radio receiver constructed to simulate a standard lamp with inconspicuous controls.

D. J. Crowley. Convention date (U.S.A.) 4th December, 1936.

509 511.—Press-button tuning control combined with a wave-change switch of the rotary type.

E. K. Cole and G. Bradfield. Application date 2nd February, 1938.

509 605.—Amplifier in which the width of a band-pass circuit is automatically varied in reverse proportion to the degree to which negative feed-back is applied.

Telefunken Co. Convention date (Germany) 18th January, 1937.

TELEVISION CIRCUITS AND APPARATUS

For Transmission and Reception

506 189.—Means for preventing television signal-fluctuations due to "fatigue" or variations in the anode potential of the carrier-wave transmitting valve.

Radio-Akt. D. S. Loewe. Convention date (Germany) 24th December, 1936.

506 691.—Mechanical scanning disc designed to avoid "keystone" distortion by receiving the incident light at an angle instead of normal to the plane of the disc.

Radio-Akt. D. S. Loewe. Convention date (Germany) 8th March, 1937.

506 709.—Double rectifier arrangement for separating the picture signals from the synchronising impulses in a television receiver.

R. J. Berry (communicated by C. Lorenz Akt.). Application date 6th September, 1938.

506 856.—Means for varying the amplitude of the saw-toothed scanning-voltages used in television without affecting their linearity.

Ferranti and H. Wood. Application date 18th February, 1938.

506 911.—Method of preparing or "conditioning" a fluorescent screen so as to produce a televised picture which persists until it is deliberately extinguished.

F. Ring. Convention date (Germany) 26th October, 1936.

506 933.—Means for "shaping" the electron stream in a cathode-ray tube so as to offset the distortion normally produced by the focusing system.

Ferranti and M. K. Taylor. Application date 28th December, 1937.

506 946.—Amplifier circuit for a wide range of frequencies, *e.g.*, in television, in which the gain is kept substantially independent of frequency.

The General Electric Co.; E. C. Cherry; and G. W. Edwards. Application dates 25th March and 2nd December, 1938.

507 059.—Preventing "tilt" distortion in television transmitter tubes, particularly those utilising double-sided mosaic screens.

J. D. McGee and H. G. Lubszynski. Application date 3rd December, 1937.

507 144.—Apparatus designed to be used either for reproducing television signals or alternately for projecting pictures directly from a standard cinema film.

Kolster-Brandes and C. N. Smyth. Application date 3rd December, 1937.

507 146.—Apparatus for producing stroboscopic illumination, particularly for use in reproducing television pictures.

Scophony and F. Okolicsanyi. Application date 7th December, 1937.

507 239.—Means for maintaining a constant datum level, and for providing an automatic correction for variations in amplitude, particularly in a television system.

A. D. Blumlein and E. L. C. White. Application date 6th November, 1937.

507 368.—Amplifier coupled to a cathode-ray tube so as to give a "gain" which is independent of frequency over a wide range of television signals.

The General Electric Co.; E. C. Cherry; G. W. Edwards; and D. C. Espley. Application date 27th April, 1938.

507 428.—Means for preventing "keystone" distortion in an interlaced scanning system.

The General Electric Co. and D. C. Espley. Application dates 13th and 21st December, 1937.

507 481.—Modulating light by the diffraction-effect of supersonic pressure-waves travelling through a transparent body.

Scophony; G. Wikken Hauser; and J. Sieger. Application date 15th November, 1937.

507 495.—Constant-impedance coupling for modulating ultra-short waves with television signals.

Radio-Akt. D. S. Loewe. Convention date (Germany) 21st, December, 1936.

507 582.—Television cabinet in which the picture is projected from the fluorescent screen on to a vertically-arranged viewing-screen.

Fernseh. Akt. Convention date (Germany) 16th December, 1936.

TRANSMITTING CIRCUITS AND APPARATUS

(*See also under Television*)

506 639.—Means for neutralizing the inter-electrode capacities in a multi-valve generator for ultra-short waves.

Telephone Manufacturing Co.; L. H. Paddle; and C. C. Whitehead. Application date 24th November, 1937.

507 100.—Calling, ringing, and supervisory arrangements for a multi-channel carrier-wave signalling system.

Telephone Manufacturing Co. and L. H. Paddle. Application date 12th February, 1938.

507 108.—Interference suppressors, particularly for use in telephone-exchanges distributing broadcast programmes.

The General Electric Co. and A. Warrington. Application date 2nd March, 1938.

507 454.—Frequency-stabilising "bridge" circuit for short-wave generators of the Magnetron type.

Telefunken Co. Convention date (Germany) 10th August, 1937.

507 764.—Wiring system for relaying or distributing signals covering a wide frequency range, particularly television.

Marconi's W.T. Co. Convention date (U.S.A.), 18th December, 1936.

507 961.—Thermionic valve arrangement for energising high-frequency "resonator" units of the "concentric line" type.

Marconi's W.T. Co. (assignees of O. E. Dow). Convention date (U.S.A.), 29th March, 1937.

CONSTRUCTION OF ELECTRONIC-DISCHARGE DEVICES

508 106.—Electron-amplifier in which the target electrodes are so arranged that the stream of secondary emission is projected in the same direction as the primary electrons.

H. G. Lubszynski and J. D. McGee. Application dates 24th November, 1927 *and 3rd June,* 1938.

508 552.—Arrangement of the cathode and control or focusing electrodes in a cathode-ray tube.

Baird Television; L. C. Daniels; and G. E. Marcus. Application date 31st December, 1937.

SUBSIDIARY APPARATUS AND MATERIALS

506 048.—Magnetron type of discharge tube arranged as a frequency-multiplier.

Telefunken Co. Convention date (Germany) 21st November, 1936.

506 072.—Method of coating the inside surface of a cathode-ray tube with a layer of carbon.

W. W. Triggs (communicated by Riedel de Haen Akt. Ges.). Application date 30th September, 1938.

506 154.—Piezo-electric microphone or loud speaker made from crystals which have been artificially "grown" from solution.

The British Thomson-Houston Co. Convention date (Germany) 17th December, 1937.

506 732.—Preventing the production of radio interference by electrically-driven labour-saving devices.

The British Thomson-Houston Co. and T. H. Kinman. Application dates 24th November and 24th December, 1937.

507 179.—Condenser with auxiliary electrodes to compensate for the effect of variations in temperature.

Marconi's W.T. Co. and D. A. Bell. Application date 10th December, 1937.

507 180.—Circuit for changing a modulated carrier-wave into a wave of the same frequency but differently modulated.

Marconi's W.T. Co. and O. E. Keall. Application date 10th December, 1937.

507 183.—Construction of high-power microphone, fitted with means for localising the impact of the sound-waves, and with means for dissipating heat.

G. R. Fountain and A. E. C. Snell. Application date 11th December, 1937.

507 381.—Method of applying a fluorescent screen to the glass wall of a cathode-ray tube so as to minimize loss of light.

The Philips' Lamp Co. Convention date (Germany) 17th June, 1937.